Photo credit: US Military Working Dog Teams National Monument, Lackland AFB, TX

CLINICAL PRACTICE GUIDELINES FOR MILITARY WORKING DOGS

Military Working Dogs (MWDs) are critical assets for military police, special operations units, and others operating in today's combat environment. Expectations are that injured working dogs will receive the highest level of resuscitative care as far forward as possible, often in the absence of military veterinary personnel. As chapters are updated, they will be pulled out of this document and published as individual clinical practice guidelines. These guidelines are not a substitute for clinical judgments. (CPG ID: 16)

Contributors

LTC (Ret) Michael Lagutchik, VC, USA ■ LTC Janice Baker, VC, USA Reserve ■ MAJ Jamie Brown, VC, USA ■ COL (Ret) Walter Burghardt, BSC, USAF ■ LTC(P) Matthew Enroth, VC, US Army ■ LTC Shannon Flournoy, VC, USA ■ L TC (Ret) James Giles, III, VC, USA ■ MAJ Patrick Grimm, VC, USA ■ LTC Jennifer Hiniker, VC, USA ■ COL Jacob Johnson, VC, USA Reserve ■ COL (Ret) Kelly Mann, VC, USA ■ MAJ (Ret) Eric Storey, VC, USA Reserve ■ LTC Matt Takara, VC, USA ■ MAJ (Ret) Todd Thomas, VC, USA ■ LT Cory Frappier, MC, USN

Table of Contents

Legend of Tables

Legend of Figures

CHAPTER 1

Scope of Healthcare Provider Responsibilities

The Scope of Healthcare Provider Responsibilities chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

Normal Clinical Parameters for MWDs

The Normal Clinical Parameters for MWDs chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 3

Emergency Airway Management

The Emergency Airway Management chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com).

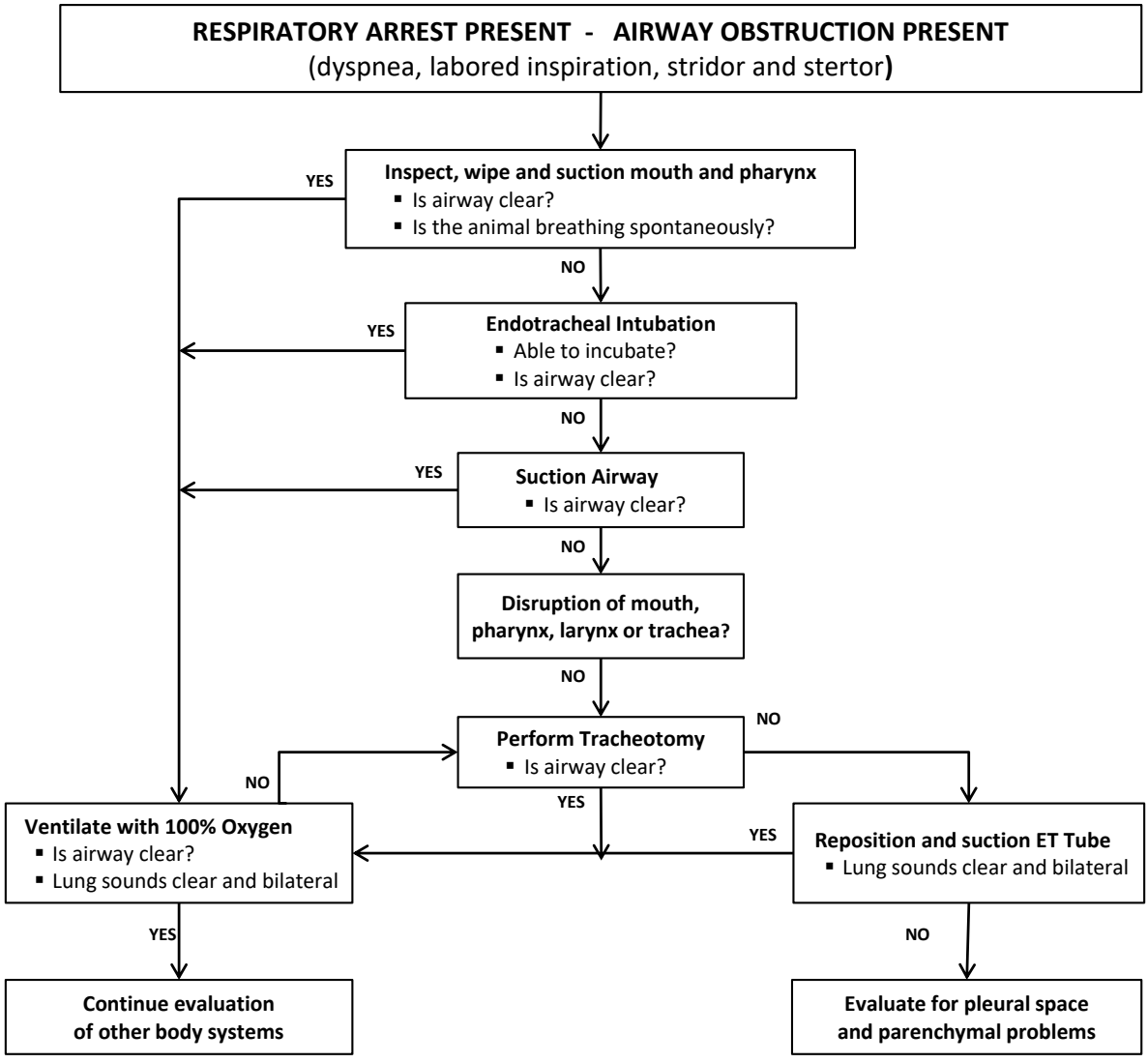
Penetrating Chest Wounds & Respiratory Distress

Respiratory distress develops in deployed MWDs most commonly due to trauma. MWDs in respiratory distress are fighting to get oxygen: they are anxious, usually have obvious problems breathing, usually have their head and neck extended, elbows and upper legs held out from the chest, don't want to lie down, and fight restraint and handling. Cyanosis, if present, is a late finding.

MWDs in respiratory distress typically have 1 of 3 characteristic breathing patterns that help localize the problem. A clinical algorithm for differentiating the most likely cause of a patient's distress based on the pattern of breathing is provided (See Figure 26).

Provide supplemental oxygen for any dog in respiratory distress (See Chapter 3).

Figure 26. Clinical Algorithm for Differentiating Cause of Distress Based on Breathing Pattern.[1]



Thoracic Radiography and Thoracic Focused Assessment with Sonography in Trauma (TFAST)

Thoracic radiography and TFAST exams are useful adjunct procedures, especially in the diagnosis and treatment of pneumothorax, hemothorax, pleural effusion, pulmonary contusions, or pulmonary edema. Radiography is also appropriate for documentation of correct thoracostomy tube placement.

Perform thoracic radiography on every traumatized MWD, if available, even if there is no clinical evidence of thoracic trauma. A significant number of trauma patients without outward evidence of chest trauma have hidden trauma that may manifest later, complicate management, or worsen with treatment of other conditions.

TFAST should be performed on every MWD that presents with a history of trauma, if the HCP has significant experience in its use; TFAST requires a high degree of experience to optimize diagnostic reliability. As with human casualties, TFAST is sensitive and specific for the diagnosis of pneumothorax and pulmonary parenchymal fluid, and for rapidly evaluating for pericardial and pleural effusions.[4] Figure 27 shows the imaging locations for TFAST in the dog. Figure 28 describes a clinical management algorithm for the use of TFAST in dogs.

Figure 27. Imaging Locations for TFAST.[4]
Figure 27 shows the ultrasound probe locations for TFAST in the dog.

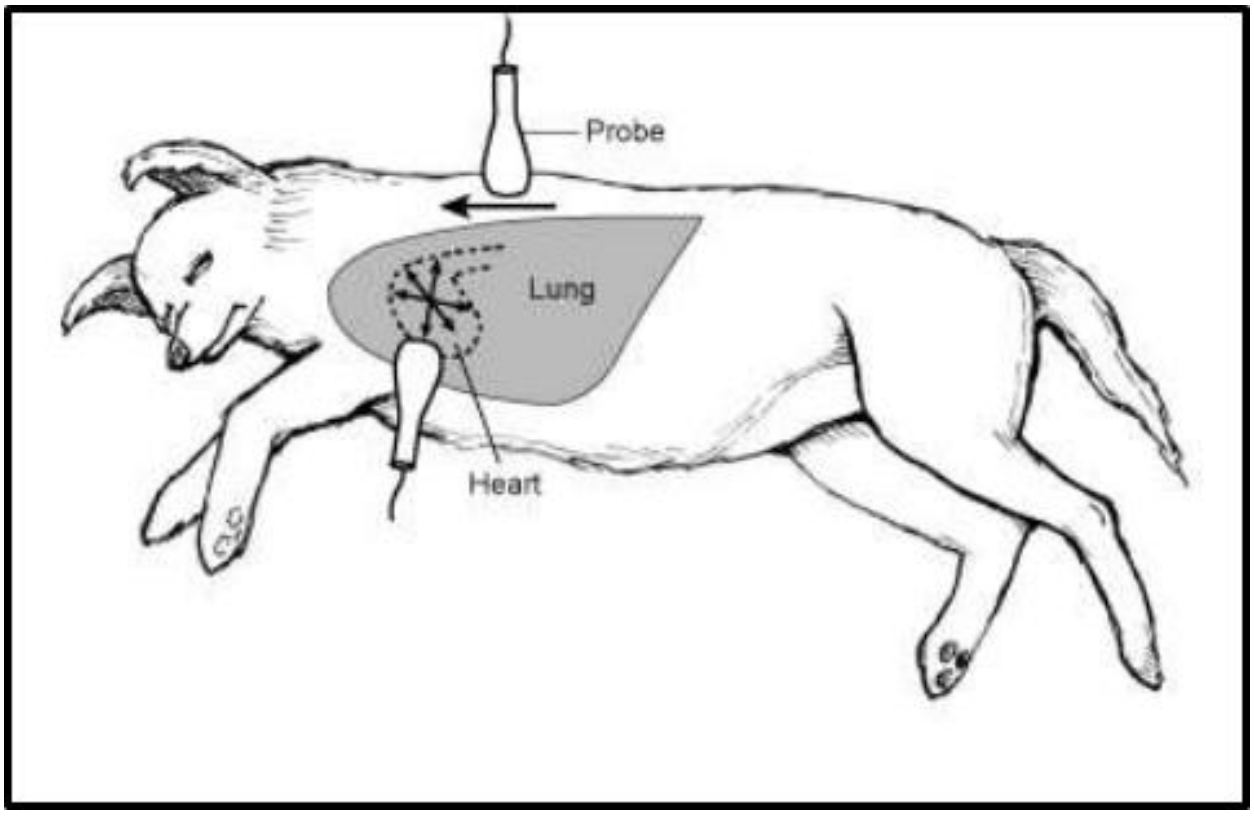
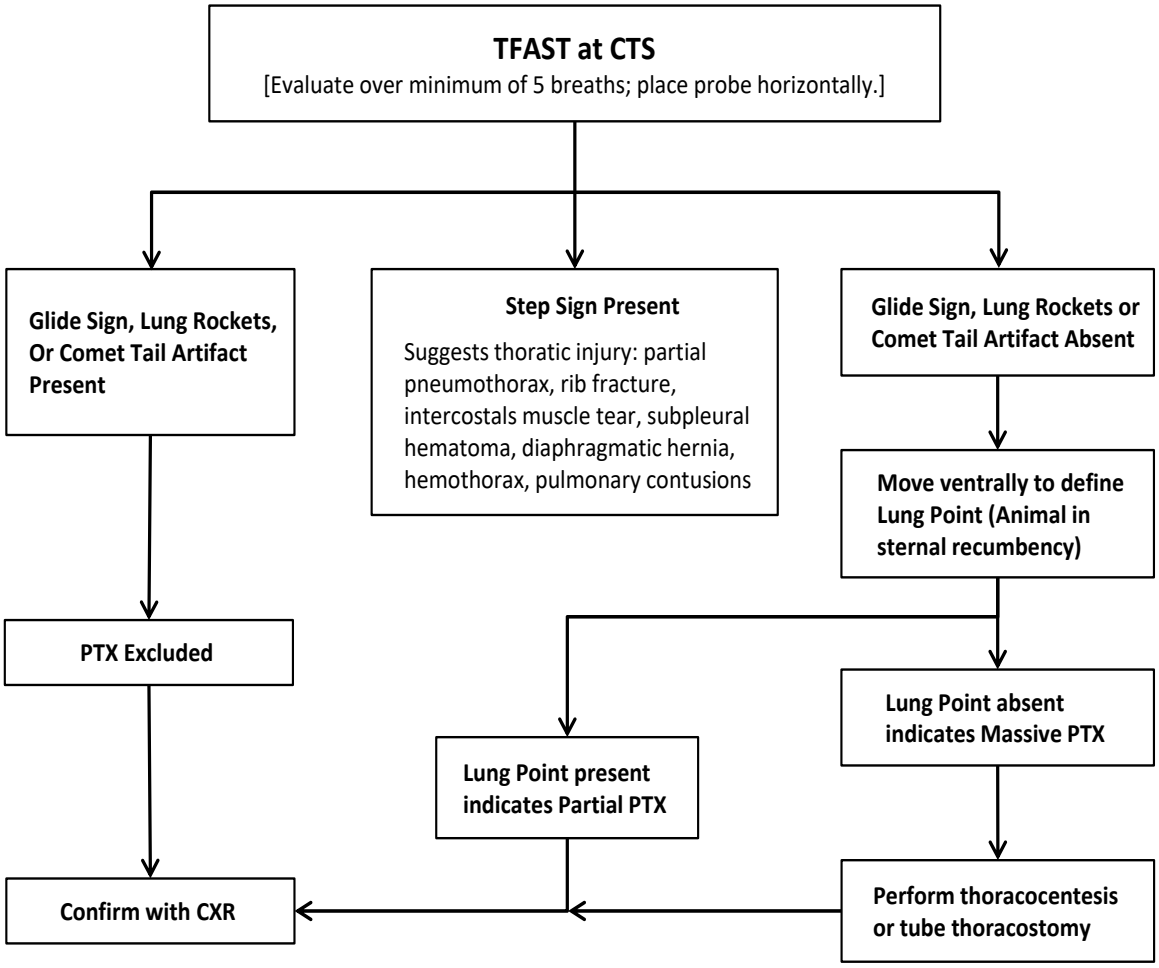


***Figure 28. Clinical Management Algorithm for TFAST Use in Military Working Dogs.*[4]**



Note: CTS refers to probe imaging location at the conventional Chest Tube Site (8th-11th intercostal space). PTX refers to pneumothorax. CXR = thoracic radiography.

Thoracic Injury

Up to 50% of traumatized dogs have some form of thoracic injury.[5-12] Pneumothorax (PTX) and pulmonary contusions are very common. Dogs with thoracic injury typically have restrictive and parenchymal breathing patterns (See Figure 26).

Rib Cage Trauma

This includes flail chest, rib fractures, intercostal muscle rupture, and penetrating wounds. Signs mimic pleural space injury (restrictive breathing pattern). Usually the defect is obvious, especially if paradoxical chest wall motion is noted.

- Adequate management usually involves careful handling, laying the patient with affected side down, minimizing restrictive chest bandaging, and providing analgesia. External splinting or surgical management is usually not necessary unless injury is severe or extensive, or the chest wall is compromised and prolonged interference with gas exchange and ventilation is evident.
- Pain can substantially interfere with gas exchange and ventilation. Alleviate pain once the patient is stabilized to improve oxygenation and ventilation. Systemic or local analgesia are acceptable options (See Chapter 16). Local nerve/rib blocks and intrapleural analgesia administration work well and are readily accomplished.

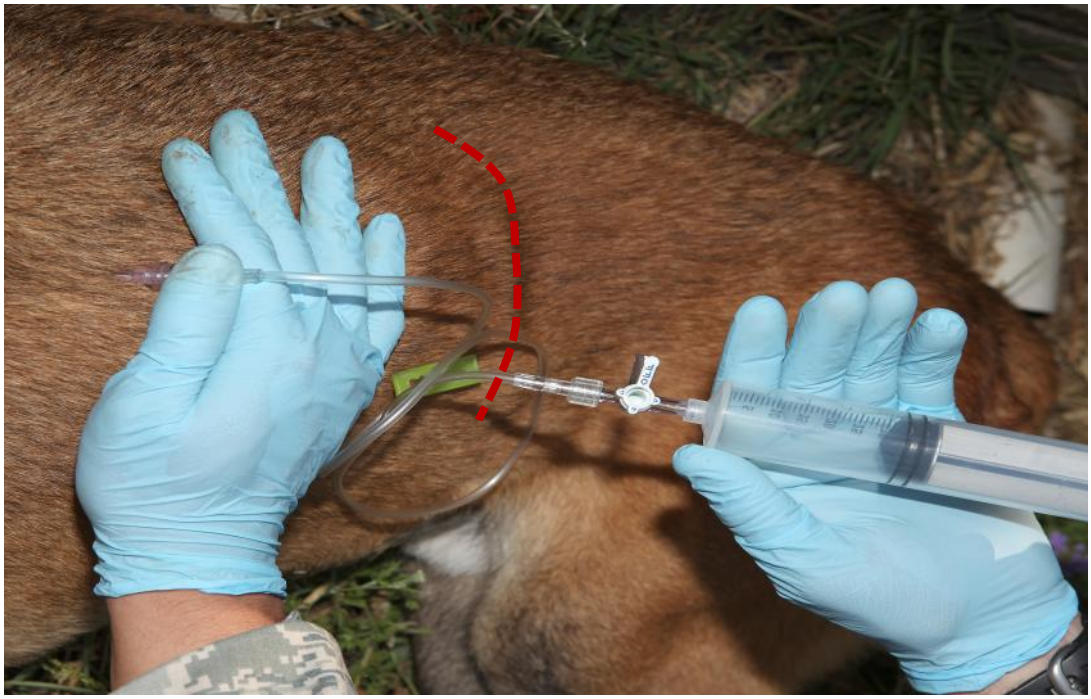
Pleural Space Trauma

This includes PTX (open, closed, tension), hemothorax (HTX), and diaphragmatic hernia. A restrictive breathing pattern is the classic presentation—shallow, rapid respiration with muffled lung and/or heart sounds. Auscult the chest for decreased lung sounds over most of the thorax, which suggests either fluid (blood) or air in the pleural space, pulmonary contusions, or diaphragmatic hernia.

- Open PTX requires immediate action. Rapidly clip hair from around the wound, and apply any occlusive seal over the wound. Apply a chest bandage to secure the material. Delay wound closure until the MWD is stable. Open PTX always requires chest decompression after closure of the wound.
- The presence of decreased lung sounds in a trauma patient with signs of respiratory distress, or rapid clinical deterioration in a MWD with respiratory distress is sufficient justification for needle thoracocentesis.
- Thoracocentesis is readily and rapidly accomplished, and safe when performed properly – "When in doubt, tap it!" Figure 29 on the next page shows the location for needle thoracocentesis in dogs.[13] See Table 8 for thoracocentesis technique in MWDs.
- The mediastinum in dogs is thin and typically ruptures; therefore, ***always tap both sides of the chest***, even if a positive tap is achieved on one side of the chest, as air will form pockets and will migrate.
- Repeated thoracenteses may be required to stabilize the patient. A negative chest tap doesn't always mean there's not an abnormal accumulation of air or fluid in the pleural space – it may mean you just couldn't find it! "When in doubt, tap it again!"
- In dogs, the intercostal artery, vein, and nerve run on the caudal aspect of each rib; thus, the best approach is by inserting the needle or catheter in the center of the intercostal space or at the cranial aspect of a rib.

Figure 29. Location for Needle Thoracocentesis.

Figure 29 shows anatomic location for needle thoracocentesis in dogs, with the dog in lateral or sternal recumbency, and the needle inserted generally on the mid-lateral thorax between the 6th to 8th intercostal space. Count forward from the last rib (#13; red dotted line) to find the insertion site.

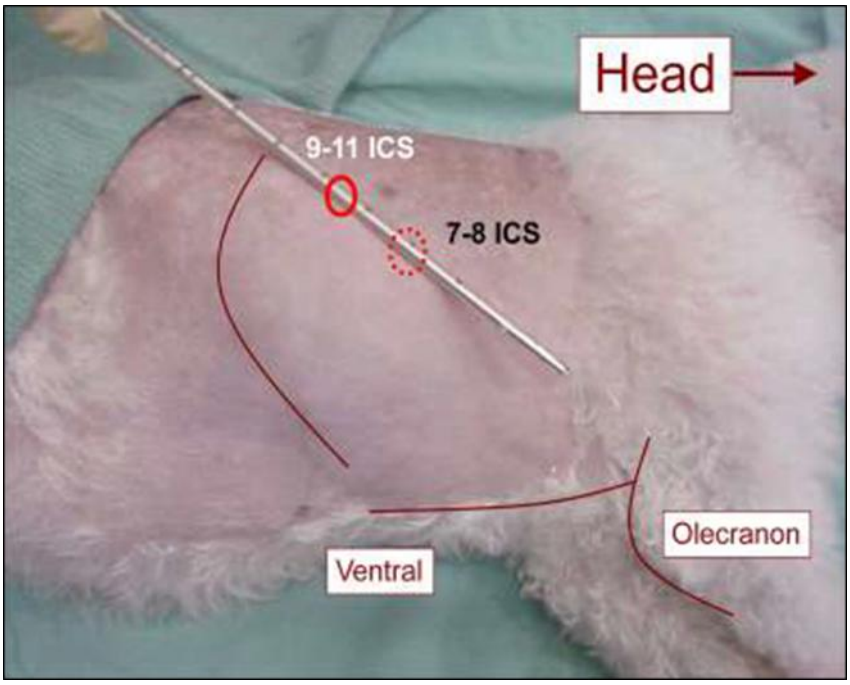


Immediate placement of a thoracostomy tube is indicated if negative pressure cannot be achieved with needle thoracocentesis, if large amounts of blood are aspirated, or if repeated thoracocenteses are required to maintain negative pleural pressure.

- A general rule of thumb for thoracostomy tube sizes is the chest tube should be the largest size that comfortably fits in the intercostal space. For most MWDs, use fenestrated tubes that are 24-36 Fr. Figure 30 shows the correct anatomic orientation for chest tubes placed in dogs. Table 9 describes techniques for chest tube placement in MWDs.
- Tube thoracostomy is a painful procedure. In emergent or critically ill patients, local analgesia may not be necessary. Consider local anesthesia, intercostal nerve blocks, and intrapleural analgesia in all other patients (See Chapter 16).
- Remove chest tubes when air or fluid accumulation is less than 2-4 mL/kg body weight per day.
- The chest tube will ideally lie in the pleural space, generally oriented cranioventrally to maximize removal of air and fluid. It is best to pre-measure the tube visually before placement to ensure proper depth of insertion. Be certain the last fenestration of the tube will be within the chest cavity.
    - Patients with chest tubes in place MUST be monitored continuously!
    - Some form of removal of air or fluid must be used. This can be continuous suction or intermittent aspiration by personnel.

Figure 30. Anatomic Orientation for Chest Tube Placement.

Figure 30 shows correct placement of a chest tube on the lateral aspect of the chest in a dog, with the tube penetrating the skin at the 9th to 11th intercostal space (ICS), tunneling cranioventrally to penetrate the chest wall at the 7th to 8th ICS, directed toward the olecranon of the elbow. Photo courtesy of Dr. Tim Hackett.



Resuscitative Thoracotomy

- Emergent thoracotomy may be indicated, keeping in mind caveats discussed previously.
- Thoracotomy in dogs is generally best done through a LEFT lateral thoracic wall approach, generally at the 4th to 5th or 5th to 6th intercostal space to afford optimal visualization. A median approach is not recommended in MWDs, given difficulties in post-operative management.
- Euthanasia should be considered for a MWD for which a resuscitative thoracotomy is deemed necessary but cannot be performed or has proven unsuccessful (See Chapter 21).

Parenchymal Trauma

Pulmonary contusions and intrabronchial hemorrhage are common. A restrictive breathing pattern may be noted in patients with mild and moderate parenchymal injury. Patients with severe parenchymal injury often have a parenchymal pattern, seen as respiratory distress with labored inspiration and expiration, with or without hemoptysis.

- Auscult the chest for decreased lung sounds, which suggest either fluid (blood) or air in the pleural space, or pulmonary contusions. A patchy distribution of altered lung sounds may be noted, which helps differentiate parenchymal injury from pleural space trauma.

- A negative thoracocentesis suggests the presence of pulmonary contusions in patients with these clinical signs. Note that radiographic signs (mixed interstitial-alveolar pattern) may lag 12-24 hours, and the stress of the process is usually not warranted.
- Hemoptysis, especially of arterialized (bright red) blood suggests significant large pulmonary vessel trauma that typically carries a very guarded prognosis.
- Most MWDs with pulmonary contusions do not require mechanical ventilation. Management of pulmonary contusions involves minimizing stress, providing oxygen supplementation, cautious intravenous fluid administration to prevent progression of contusions and/or development of pulmonary edema, and possible addition of colloids to the fluid therapy plan to decrease the amount of lung water that may accumulate during shock resuscitation. Diuretics and steroids are not indicated in treatment of pulmonary contusions, and may increase patient morbidity and mortality.
- Severe, life-threatening major pulmonary vessel hemorrhage may require resuscitative thoracotomy. Refer to the discussion of **Resuscitative Thoracotomy** in this chapter for guidance and technique.

Diaphragmatic Hernia

Auscultation of borborygma over the area of the lung field suggests the presence of a diaphragmatic hernia, but can be misleading. Standard radiography and ultrasonography procedures are diagnostic. Assume a hernia is present, and carefully manage the patient to minimize discomfort and further organ herniation until the patient is stable enough to allow definitive diagnosis of the hernia.

- ***Diaphragmatic hernia (DH) is usually not considered a surgical emergency unless the stomach is involved, or the patient's condition deteriorates or fails to respond to conservative management.*** In most cases, the patient should be stabilized for shock and other organ injury, with definitive repair of the hernia at a later time. Most patients suffering trauma severe enough to rupture the diaphragm have other pulmonary injuries that would preclude anesthesia and intermittent positive pressure ventilation (IPPV) (e.g., contusions, pneumothorax).
- Emergent repair of a DH may be indicated. Repair is performed via a cranial ventral midline laparotomy, with retraction of the liver and stomach caudally, to afford optimal visualization.
  - Some means of positive pressure ventilation is necessary intraoperatively.
  - At least 1 thoracostomy tube should be placed intraoperatively and maintained for at least 24 hours post-operatively to manage pneumothorax.
  - Generally, rents in the diaphragm due to trauma occur in the muscular portions of the diaphragm, and are readily repaired using a simple continuous suture closure.

Ventilatory Support

Ventilatory support (e.g., manual IPPV or mechanical ventilation) may be required for dogs that fail to respond to correction or stabilization of the primary respiratory problem and supplemental oxygen support.[15] Ventilatory support requires a heavily sedated or anesthetized patient, even if a tracheostomy tube is in place (See Chapter 16).

- Manual intermittent positive pressure ventilation (MIPPV) is feasible if personnel can be spared for this, and is ideal for short-term (i.e., <6 hours) of ventilator support.
- There may be instances in which mechanical ventilation (MV) is necessary to afford a chance for patient survival. MV may be necessary if MIPPV fails or duration of ventilator support is expected to be >6 hours. Providers must note that MV should be considered only if the provider has the necessary advanced MV training and experience, the provider feels there is a reasonable likelihood of success, and the provider has the necessary support staff, facilities, and monitoring and intensive care facilities to manage a MWD on MV without compromising human patient care. Thus, MV should be considered only in Level 2 or higher medical facilities and by trained specialists with adequate staff.
- Generally, it is best to induce general anesthesia and initially manage the ventilated dog using Controlled Ventilation or Assist-Control ventilator mode. Key ventilator settings are shown (See Table 7).

TABLE 7: MECHANICAL VENTILATOR SETTINGS & KEY PARAMETERS[13]

PARAMETER	NORMAL LUNGS	ABNORMAL LUNGS
F_IO_2	100%, then reduce to <60%	100%, then reduce to <60%
Tidal Volume (V_T)	5 – 15 mL/kg	5 – 15 mL/kg
Breathing Rate (f)	8 – 20 bpm	8 – 20 bpm
Minute Ventilation (V_E)	150 – 250 mL/kg/min	150 – 250 mL/kg/min
Peak Inspiratory Psi (PIP)	10 – 20 cmH_2O	15 – 25 cmH_2O
Positive End-Expiratory Psi (PEEP)	0 – 2 cmH_2O	2 – 8 cmH_2O
Trigger Sensitivity	-2 cmH_2O or 2 L/min	-2 cmH_2O or 2 L/min
Inspiratory: Expiratory Ratio (I:E)	1:2	1:2
Inspiratory Time	~ 1 sec	~ 1 sec

TABLE 8. NEEDLE THORACOCENTESIS OF MWDS[14]
1. Position the animal in sternal recumbency if conscious or lateral recumbency if unconscious, sedated, or anesthetized.
2. Clip the hair from and surgically prepare a 6 inch X 6 inch square area of skin on the mid-lateral aspect of the thorax centered between the 6th to 8th ribs. ■ If pneumothorax is suspected, prepare the thoracenteses sites at the junctions of the upper 1/3rd and lower 2/3rds of the thoracic wall. ■ If pleural effusion is suspected, prepare the thoracenteses sites at the costochondral junctions.
3. In conscious MWDs and if time, infiltrate 1 mL of local anesthetic (20 mg lidocaine or 5 mg bupivacaine) in the skin to the pleura.
4. Assemble an emergency thoracocentesis set. For a tension PTX, a 1-1.5 inch, 16-18 gauge over-the-needle catheter is sufficient to relieve tension. For other types of PTX, use a 1-1.5 inch, 18 gauge over-the-needle catheter, to which sterile extension tubing and a stopcock and 60 cc syringe are attached; this allows aspiration of air and fluid without iatrogenic PTX. ***Do NOT use the standard Needle Decompression Device (3.25 inch, 16 gauge), as risk of cardiac or pulmonary vessel trauma is high.***
5. Hold the needle with the thumb and index finger of one hand and brace the hand on the lateral aspect of the thorax by firmly resting the "knife" of the hand on the thorax near the proposed thoracocentesis site.
6. Hold the syringe in your dominant hand, or have an assistant manipulate the syringe and stopcock while you manipulate the needle. The syringe should be empty and the stopcock closed to room air.
7. While stabilizing the hand holding the needle, insert the needle at the proposed thoracocentesis site through the skin, intercostal muscles, and parietal pleura until ½ the length of the needle has been inserted.
8. While stabilizing the depth of the needle with your non-dominant hand, aspirate with the syringe plunger in an attempt to remove air or fluid.
9. If you are successful in removing air or fluid, close the stopcock to the patient and expel the contents from the syringe through the stopcock without removing the needle from the pleural space or breaking aseptic technique.
10. Repeat until no further air or fluid can be removed.
11. If you are not successful in removing air or fluid, insert the needle to the hub while aspirating with the syringe, or redirect the needle cranially, caudally, dorsally and ventrally, or do both in an attempt to tap a pocket of air or fluid.
12. If you are still unsuccessful in removing air or fluid, completely remove the needle from the thorax and attempt thoracocentesis in an intercostal space cranial or caudal to the initial site.

TABLE 9. TUBE THORACOSTOMY OF MILITARY WORKING DOGS[15]

1. Clip the hair from and surgically prepare an area of skin from the 4th to the 12th rib, and from the dorsal midline to the ventral midline.

2. Infiltrate local anesthetic (20 mg lidocaine +/- 10 mg bupivacaine) at the proposed skin incision site between the 9th and 11th intercostal space at the junction of the upper 1/3rd and the lower 2/3rds of the lateral thorax. Continue infiltration of the subcutaneous tissues cranioventrally to the intercostal space at the intended site of penetration of the thoracic wall between the 6th and 8th intercostal space. Infiltrate the intercostal muscles, down to the level of the parietal pleura.

3. Make a skin incision with a #10 scalpel blade that is the same diameter as the thoracostomy tube. Note that an incision that is too large increases the risk of iatrogenic PTX and fluid leakage.

4. Insert the thoracostomy tube using either a trocar or forceps through the skin incision and advance the tube cranioventrally toward the intercostal space where you intend to penetrate the thorax. This creates a subcutaneous tunnel and orients the tube to lie in the intended direction in the chest.

   Note: *The interval between the skin incision and the intercostals space where the tube penetrates the thorax must be at least 2 intercostal spaces in width to allow sufficient creation of a subcutaneous tunnel that is important in minimizing iatrogenic PTX and fluid leakage.*

   Note*: MWDs rarely develop pleural adhesions, so digital exploration before tube placement is not necessary.*

   Trocar Technique: (RECOMMENDED technique)

   1) Insert the tip of the tube through the skin incision and advance the tube subcutaneously cranio-ventrally at least 2 intercostal spaces. Be sure to hold the trocar firmly in the tube.
   2) Firmly drive the tip of the stylet into the intercostal musculature as you raise the thoracostomy tube vertically so that the tube is almost perpendicular to the thorax.
   3) This movement will cause the skin to bunch over the intercostal space and will expose the distal part of the tube that was in the skin tunnel.
   4) Firmly grasp the distal-most part of the thoracostomy tube with one hand approximately 2 cm from the tip to prevent inadvertent over insertion of the trocar when advancing the tube in the next step. Note that this step is vital, as this hand acts as a “brake” to prevent lung and heart trauma as the tube is inserted.
   5) Using either a single, sharp blow to the proximal blunt end of the stylet or firm continuous downward pressure on the proximal blunt end of the stylet, penetrate the intercostal muscles and pleura to advance the tube into the pleural space approximately 2 cm.
   6) Once the tip of the thoracostomy tube has been inserted approximately 2 cm into the pleural space, lay the tube flat against the body wall AS YOU BEGIN TO ADVANCE THE TUBE in the pleural space cranioventrally toward the point of the elbow.
   7) As the tube is advanced, begin to slide the stylet out of the tube.
   8) Clamp the thoracostomy tube using the box lock of the Rochester-Carmalt or similar forceps as the stylet is removed to prevent pneumothorax.
   9) Close the proximal (outer) opening of the thoracostomy tube using either a Heimlich valve or tubing adapter and stopcock so that air does not enter the pleural space.

TABLE 9. TUBE THORACOSTOMY OF MWDS[15] (CONTINUED)

Forceps Technique: (NOT ideal; more traumatic and technically demanding)

1) Create a subcutaneous tunnel by bluntly advancing a 7" curved Rochester-Carmalt forceps or similar forceps (without the tube) cranioventrally from the skin incision site to the proposed intercostal space where the thoracostomy tube will penetrate the thorax.
2) Forcefully drive the tip of the forceps through the intercostal muscles and parietal pleura using a firm, quick thrusting motion, to enter the chest cavity.
3) While the tips of the forceps are inserted through the intercostal muscles and pleura, firmly open the jaws of the forceps to dilate the penetration site in the thoracic wall.
4) Remove the forceps and grasp the distal end of the thoracostomy tube with the jaws of the forceps such that the length of the tube is lying over the handles of the forceps. Just a small part of the tip of the tube should extend beyond the tip of the forceps.
5) Attach a Heimlich valve or clamp the thoracostomy tube BEFORE placing the tube to prevent pneumothorax.
6) Insert the forceps holding the tube through the skin incision and advance the tube and forceps cranioventrally through the subcutaneous tunnel to and through the intercostal opening.
7) Without removing the forceps, open the jaws of the forceps to release the thoracostomy tube. Advance the thoracostomy tube into the pleural space in a cranioventral direction toward the point of the elbow.
8) As the thoracostomy tube is advanced into the pleural space, slowly remove the forceps completely.
9) Continue to advance the thoracostomy tube until you are absolutely certain the most proximal fenestration of the tube is well within the pleural space, and is not in the subcutaneous tunnel or outside the skin.

5. Secure the chest tube to the skin using a horizontal mattress suture through the skin ventral to the skin tunnel, a purse string suture at the skin incision site that surrounds the tube where it enters the skin, and a "finger trap" suture around the tube anchored to the skin. Incorporate the chest tube in a bandage applied around the thorax to protect the tube.

References for Penetrating Chest Wounds & Respiratory Distress

1. Macintire DK, Drobatz KJ, Haskins SC, Saxon WD. Respiratory emergencies. In: Manual of Small Animal Emergency and Critical Care Medicine. Baltimore: Lippincott Williams and Wilkins, 2005;115-118.
2. Mazzaferro E. Oxygen therapy. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;77-80.
3. Tseng LW, Drobatz KJ. Oxygen supplementation and humidification. In: King LG, ed. Textbook of Respiratory Disease in Dogs and Cats. St. Louis: Saunders/Elsevier, 2004:205-213.
4. Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. J Vet Emerg Crit Care 2008;18:258-269.
5. Baker JL, Havas KA, Miller LA, et al. Gunshot wounds in military working dogs in Operation Enduring Freedom and Operation Iraqi Freedom: 29 cases (2003-2009). J Vet Emerg Crit Care 2013;23:47-52.
6. Intarapanich NP, McCobb EC, Reisman RW, et al. Characterization and comparison of injuries caused by accidental and non-accidental blunt force trauma in dogs and cats. J Forensic Sci 2016;61:993-999.
7. Kolata RJ, Johnston DE. Motor vehicle accidents in urban dogs: A study of 600 cases. J Am Vet Med Assoc 1975;167:938-941.
8. Kolata RJ, Kraut NH, Johnston DE. Patterns of trauma in urban dogs and cats: A study of 1000 cases. J Am Vet Med Assoc 1974;164:499-503.
9. Kovacic JP. Management of life-threatening trauma. Vet Clin N Am Small Anim Pract 1994;24:1057-1094.
10. Merck MD, Miller DM, Reisman RW, et al. Blunt Force Trauma. In: Veterinary Forensics: Animal Cruelty Investigations. Somerset: Wiley, 2012:97-120.
11. Ressel L, Hetzel U, Ricci E. Blunt force trauma in veterinary forensic pathology. Vet Pathol 2016;53:941-961.
12. Simpson SA, Syring RS, Otto CM. Severe blunt trauma in dogs: 235 cases (1997-2003). J Vet Emerg Crit Care 2009;19:588-602.
13. Hopper K. Basic mechanical ventilation. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;161-165.
14. Sigrist N. Thoracocentesis. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;1029-1031.
15. Sigrist N. Thoracostomy tube placement and drainage. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;1032-1036.

CHAPTER 5

Cardiopulmonary Resuscitation (CPR)

The CPR for MWDs chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 6

Shock Management

Shock in deployed MWDs will most likely be due to hemorrhage from trauma or hypovolemia due to heat injury or gastrointestinal losses. Control bleeding (if present) and then stabilize the patient using targeted fluid therapy. Figure 33 provides a clinical management algorithm for shock management in MWDs.

Immediate Hemorrhage Control

Treatment by handlers and combat medics may have been performed, with varying degrees of success.[1,2] Expect dogs to arrive with pressure dressings, hemostatic gauze packed into wounds, and improvised tourniquets. Expect untreated or inadequately treated extremity hemorrhage, and suspect "hidden" intracavitary hemorrhage in the chest and abdomen.

- Assess for unrecognized hemorrhage and control all sources of external bleeding. Use direct pressure initially, or rapidly clamp and ligate major vessels if traumatized. Dogs have excellent collateral circulation, and paired major vessels can be ligated without concern for tissue ischemia or edema, to include the femoral arteries and veins, external jugular veins, external carotid arteries, and brachial arteries and veins.[3,4]
- Tourniquets are unreliable on the limbs of dogs due to the anatomic shape of the leg. Conventional human tourniquets do not remain in place or effectively control hemorrhage. Some success is reported in use of improvised tourniquets, such as surgical rubber tubing or constrictive gauze bandage. If delay in definitive care of major extremity trauma is expected, use hemostatic agents, direct pressure, and compressive bandaging to assist with hemorrhage control.
- Use thoracic FAST (TFAST) and abdominal FAST (AFAST) to rapidly scan for intracavitary fluid (See Chapter 4 and Chapter 7).[5,6] Assume intracavitary fluid is due to bleeding until proven otherwise.

Clinical Signs of Shock in MWDs[7,8]

Dogs in shock are amazing in how stable they appear on initial presentation, due to compensatory mechanisms.

- MWDs in early (compensatory) shock may have tachycardia, tachypnea, alert mentation, rapid arterial pulses with a normal or increased pulse pressure, decreased capillary refill time (< 2 seconds), and normal or bright red mucous membranes. While this MWD seems normal, it is already in compensatory shock. Immediate treatment at this point may stop the progression of shock.
- As the early decompensatory phase of shock begins, tachycardia persists, pulse pressure and quality begins to drop or may be normal, capillary refill time becomes prolonged, mucous membranes appear pale or blanched, peripheral body temperature drops, and mental depression develops. Aggressive treatment must be provided to halt ongoing shock.
- As late decompensatory shock develops, the heart rate drops despite a decreased cardiac output, capillary refill time is very prolonged or absent, pulses are poor or absent, both peripheral and core temperature is very low, and marked mental depression (stupor) is present. Irreversible cellular injury may be present to such a severe degree that despite aggressive measures at this point, many patients will die.

Standard Shock Therapy

Provide immediate fluid therapy targeted to specific endpoints, provide supplemental oxygen, and identify and treat the cause for the shock. Tranexamic acid (TXA) or ε-aminocaproic acid (EACA) may be helpful in dogs with catastrophic hemorrhage.

1. Place multiple large-bore IV or IO catheters or perform venous cut-down.

   - Do not delay in placing catheters. *The IO route is rapid, reliable and safe — USE IT!* Place peripheral or central lines when feasible. If one percutaneous attempt is not successful in a shock patient, immediately choose an alternate percutaneous site and also begin an immediate venous cutdown or perform IO catheterization. The cephalic veins and external jugular veins are ideal for peripheral catheterization.

   - The proximal cranial medial tibia and the proximal lateral humerus are ideal for IO catheter placement, using the same technique as for people (See Figures 34-37). Most MWDs weigh >40#, so use adult (25mm X 15 gauge) IO catheters. Use pediatric (15mm X 15 gauge) IO catheters in dogs weighing less than 40#.

2. Give crystalloid fluids as the first-line treatment.[9-14]

   - Normosol-R® or Plasmalyte-A® are optimal for dogs; however, saline or LRS are acceptable in emergent cases.

   - Crystalloid fluid challenges, as needed based on response to therapy, are better than large volume fluid administration.[11-13] Be prepared to administer up to 90 mL/kg of crystalloids in the first hour (1 blood volume for the dog). Aggressive, but careful, fluid delivery, with frequent reassessment of the patient's status, is critical. Most MWDs can be resuscitated with much less than this calculated maximum volume.

   - For quick reference, ADD a ZERO to the dog's body weight (***in pounds***) to approximate a safe but effective bolus volume. For example, a 45# dog would need about a 450 mL bolus, and a 75# dog would need about 750 mL as a bolus.

3. Use synthetic colloids and hypertonic saline (HTS) in dogs with refractory shock. Very limited data in dogs suggest increased risks,[15-18] but dogs do not seem as sensitive to the adverse effects of these fluids as are people. Two recent studies in dogs showed no adverse side effects, specifically acute kidney injury, with tetrastarch use.[19,20] The benefits outweigh the risks, so be aggressive with synthetic colloid and HTS.[15-17]

   - Give hydroxyethyl starch (HES) as an IV or IO bolus of 10-20 mL/kg total over 5-10 minutes if clinical signs of shock do not abate after the first 30 minutes or the first 2 bolus crystalloid challenges), or response to crystalloid challenges is not sustained.[11-13,15,20,21] Repeat this bolus if no response to therapy.

   - Use HTS IV boluses, if 7.0 - 7.5% HTS is available, for MWDs that fail to respond to 2 or 3 boluses of crystalloids and/or 1 or 2 boluses of HES. Give 4 mL/kg over 5 minutes.[11-13,20] Do not administer HTS by the IO route.

Standard Shock Therapy (continued)

4. Human serum albumin (HSA) use. Do not give HSA or other synthetic colloids (e.g., dextrans) to MWDs, because severe allergic reactions are possible (HSA) and coagulopathies are common (dextrans). Some data suggest benefit in a very limited subset of patients with severe hypoalbuminemia,[22,23] but risks far outweigh potential benefit in dogs with shock.

5. Blood product use. Canine blood products are not available for immediate HCP use.[2] Dogs cannot be transfused with human blood products. HCPs will have to manage hemorrhagic shock with crystalloid and colloid therapy.

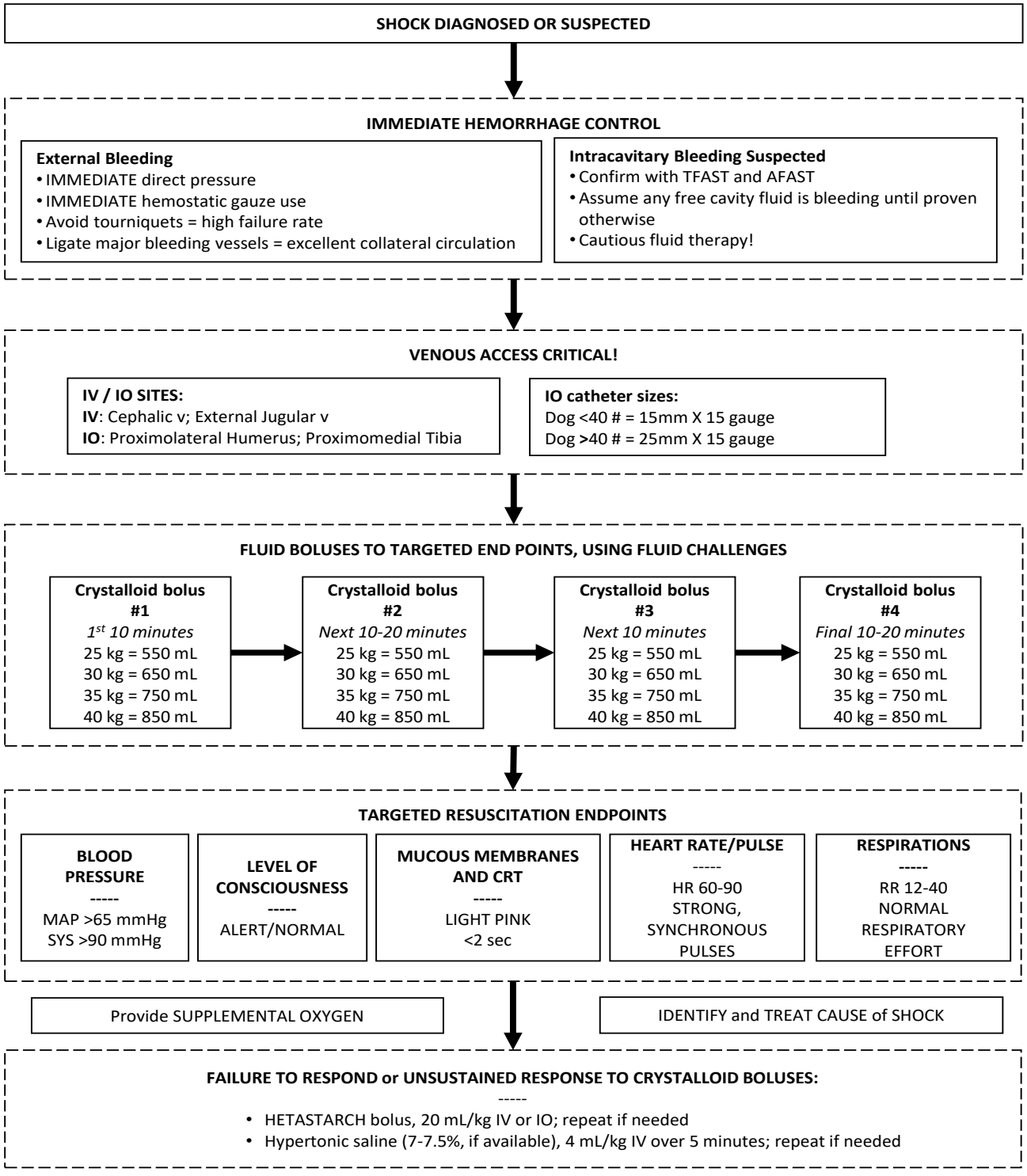
6. Tranexamic acid (TXA) and ε-aminocaproic acid (EACA) use. There is limited, but promising, data to guide use of TXA[24-27] and EACA[28] in dogs with hemorrhage. Dogs appear to be hyperfibrinolytic compared to humans, suggesting higher doses of TXA may be needed in dogs. Consider TXA or EACA if the dog is anticipated to need significant blood transfusion, such as severe hemorrhagic shock, limb amputation, penetrating torso trauma with severe non-compressible bleeding, because canine blood products are not available. Administer these drugs as soon as possible after trauma, but NO LATER THAN 3 HOURS post injury.
   - TXA: 10 mg/kg in 100 mL NS or LRS, IV over 15 min.
   - EACA: 150 mg/kg in 100 mL NS or LRS, IV over 15 min.
   - If bleeding continues, a CRI of additional TXA at 10 mg/kg/hour for 3 hours can be administered.

7. Targeted shock resuscitation end points that are practical for HCPs include systolic and mean arterial pressures, level of consciousness and mentation, mucous membrane color and capillary refill time, HR, RR, and pulse quality.
   - Target a MAP >65 mmHg or a Sys >90 mmHg. Note that neonatal or pediatric blood pressure cuffs must be used (See Chapter 2).
   - Target normal level of consciousness (LOC) and an alert mentation.
   - Target light pink-to-salmon pink MM and a CRT <2 seconds.
   - Target a HR that is 60-90 beats per minute at rest with a strong, synchronous pulse quality.
   - Target a respiratory rate at rest of 12-40 breaths per minute with normal effort.
   - Once shock has abated, continue IV crystalloid fluids at 3-5 mL/kg/hour for 12-24 hours to maintain adequate intravascular volume.

8. Provide supplemental oxygen therapy. Oxygen supplementation is critical. Every shock patient should receive supplemental oxygen therapy until stable (See Chapter 3).

9. Identify and treat the cause of shock. The cause of shock must be corrected, if possible.
   - Patients with massive intra-abdominal or intrathoracic bleeding need surgery to find the site of bleeding and surgically correct the loss of blood, with the caveats in mind as discussed previously.
   - Chapter 4 addresses emergent resuscitative thoracotomy. Chapter 7 addresses emergent abdominal laparotomy.
   - Euthanasia should be considered to prevent undue suffering for a MWD for which emergent surgery is deemed necessary but cannot be performed or has proven unsuccessful (See Chapter 21).

Figure 33. Clinical Management Algorithm for Shock Resuscitation in MWDs.



Figures 34-37. Intra-osseous Catheter Placement (Tibia) in a MWD.
Note: Sterile draping is removed to provide better visualization; perform catheterization using sterile technique.

Figure 34 shows the general landmark for IO catheterization on the upper medial aspect of the hind leg of the dog.

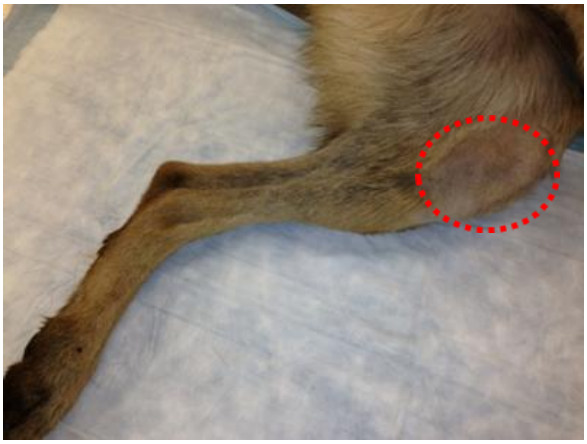


Figure 35 shows the intended insertion site (red oval) on the proximal medial tibial crest, just distal to the knee joint. The area should be clipped of hair and prepared for aseptic catheter placement.

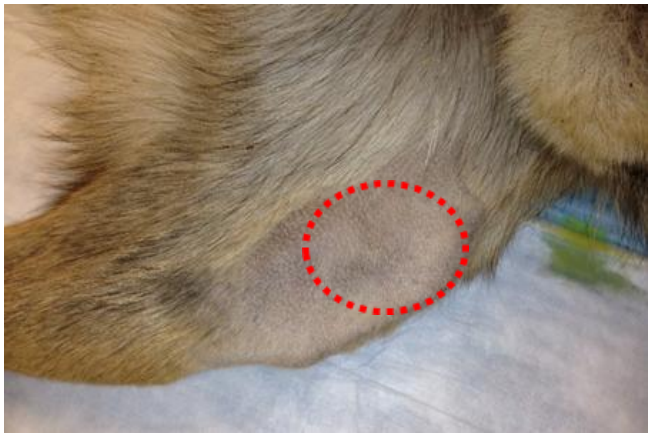


Figure 36 shows insertion of a pediatric IO catheter in the proximomedial tibia using the EZ-IO® device.

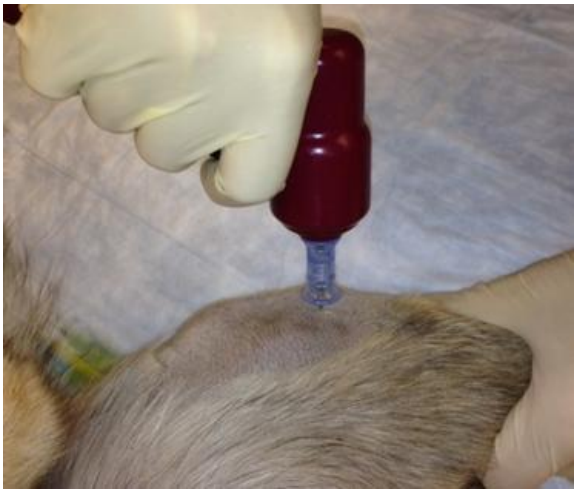
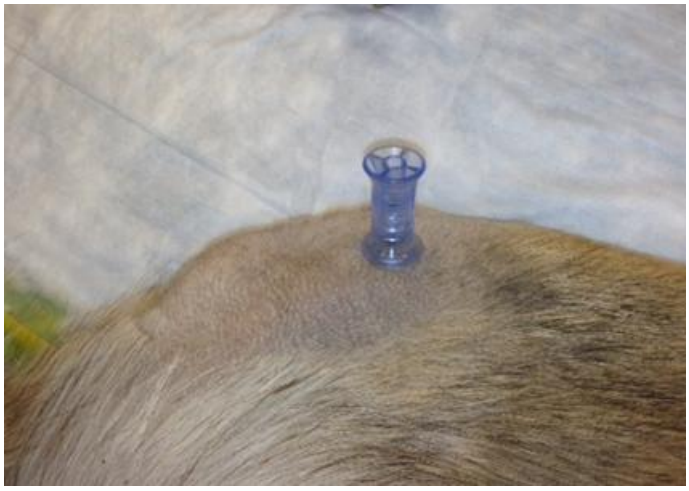


Figure 37 shows full insertion of the IO catheter, after removal of the stylet.



Shock Management References

1. Baker JL, Havas KA, Miller LA, et al. Gunshot wounds in military working dogs in Operation Enduring Freedom and Operation Iraqi Freedom: 29 cases (2003-2009). J Vet Emerg Crit Care 2013;23:47-52.

2. Giles III, JT. Role of human health care providers and medical treatment facilities in military working dog care and accessibility difficulties with military working dog blood products. US Army Medical Department Journal April-September 2016:157-160. Available at http://www.cs.amedd.army.mil/amedd_journal.aspx, accessed 29 September 2016, pp 157-160.

3. Coffman JD. Peripheral collateral blood flow and vascular reactivity in the dog. J Clin Investigation 1966;45:923-931.

4. Whisnant JP, Millikan CH, Wakim KG, et al. Collateral circulation to the brain of the dog following bilateral ligation of the carotid and vertebral arteries. Am J Physiol 1956;186:275-277.

5. Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. J Vet Emerg Crit Care 2008;18:258-269.

6. Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of an abdominal fluid scoring (AFS) system determined using abdominal focused assessment with sonography for trauma (AFAST) in 101 dogs with motor vehicle trauma. J Vet Emerg Crit Care 2009;19:426-437.

7. Raffe MR, Wingfield WE. Hemorrhage and hypovolemia. In: The Veterinary ICU Book. Wingfield WE and Raffe MR, eds. Jackson Hole: Teton New Media, 2002;453-478.

8. Crowe DT, Jr., Devey JJ. Assessment and management of the hemorrhaging patient. Vet Clin N Am (Small Anim Pract), 1994;24:1095-1122.

9. Kovacic JP. Management of life-threatening trauma. Vet Clin N Am Small Anim Pract 1994;24:1057-1094.

10. Drobatz K. Triage and initial assessment. In: Manual of Canine and Feline Emergency and Critical Care. King L and Hammond R, eds. British Small Animal Veterinary Association, 1999;1-7.

11. Balakrishnan A, Silverstein D. Shock fluids and fluid challenge. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;321-327.

12. De Laforcade A, Silverstein D. Shock. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;26-30.

13. Liu D, Silverstein D. Crystalloids, colloids, and hemoglobin-based oxygen carrying solutions. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;311-316.

14. Hanel RM, Palmer L, Baker J, et al. Best practice recommendations for prehospital veterinary care of dogs and cats. J Vet Emerg Crit Care 2016;26:166-233.

Shock Management References (continued)

15. Glover PA, Rudloff E, Kirby R. Hydroxyethyl starch: a review of pharmacokinetics, pharmacodynamics, current products, and potential clinical risks, benefits, and use. J Vet Emerg Crit Care 2014;24:642-661.

16. Adamik KN, Yozova ID, Regenscheit N. Controversies in the use of hydroxyethyl starch solutions in small animal emergency and critical care. J Vet Emerg Crit Care 2015;25:20-47.

17. Wurlod VA, Howard J, Francey T, et al. Comparision of the in vitro effects of saline, hypertonic hydroxyethyl starch, hypertonic saline, and two forms of hydroxyethyl starch on whole blood coagulation and platelet function in dogs. J Vet Emerg Crit Care 2015;25:474-487.

18. Hayes G, Benedicenti L, Mathews K. Retrospective cohort study on the incidence of acute kidney injury and death following hydroxyethyl starch (HES 10% 250/0.5/5:1) administration in dogs (2007-2010). J Vet Emerg Crit Care 2016;26:35-40.

19. Sigrist NE, Kalin, N, Dreyfus A. Changes in serum creatinine concentration and acute kidney injury (AKI) grade in dogs treated with hydroxyethyl starch 130/0.4 from 2013 to 2015. J Vet Intern Med 2017;31:434-441.

20. Yozova ID, Howard J, Adamik KN. Retrospective evaluation of the effects of administration of tetrastarch (hydroxyethyl starch 130/0.4) on plasma creatinine concentration in dogs (2010-2013): 201 dogs. J Vet Emerg Crit Care 2016;26:568-577.

21. Hammond TN, Holm JL, Sharp CR. A pilot comparison of limited versus large fluid volume resuscitation in canine spontaneous hemoperitoneum. J Am Anim Hosp Assoc 2014; 50:159–166.

22. Gauthier V, Holowaychuk MK, Kerr CL, et al. Effect of synthetic colloid administration on hemodynamic and laboratory variables in healthy dogs and dogs with systemic inflammation. J Vet Emerg Crit Care 2014; 24:251-258.

23. Vigano F, Perissinotto L, Bosco VRF. Administration of 5% human serum albumin in critically ill small animal patients with hypoalbuminemia: 418 dogs and 170 cats (1994-2008). J Vet Emerg Crit Care 2010;20:237-243.

24. Mathews KA, Barry M. The use of 25% human serum albumin: outcome and efficacy in raising serum albumin and systemic blood pressure in critically ill dogs and cats. J Vet Emerg Crit Care 2005;15:110-118.

25. Fletcher DJ, Blackstock KJ, Epstein K, et al. Evaluation of tranexamic acid and ε-aminocaproic acid concentrations required to inhibit fibrinolysis in plasma of dogs and humans. Am J Vet Res 2014;75:731-738.

26. Kelmer E, Marer K, Bruchim Y, et al. Retrospective evaluation of the safety and efficacy of tranexamic acid (Hexakapron®) for the treatment of bleeding disorders in dogs. Israel J Vet Med 2013;68:94-100.

27. Kelmer E, Segev G, Papashvilli V, et al. Effects of IV administration of tranexamic acid on hematological, hemostatic, and thromboelastographic analytes in healthy adult dogs. J Vet Emerg Crit Care 2015;25:495-501.

28. Marin LM, Iazbik MC, Zaldivar-Lopez S, et al. Epsilon aminocaproic acid for the prevention of delayed postoperative bleeding in retired racing greyhounds undergoing gonadectomy. Vet Surg 2012;41:594-603.

Abdominal Trauma

Abdominal Injuries in Deployed MWDs

These injuries are the result of either blunt abdominal trauma (BAT) or penetrating abdominal trauma (PAT).[1-7] Management of these types of injuries differs markedly. Conservative medical management is usually indicated for MWDs with blunt abdominal trauma; whereas, urgent exploratory surgery is generally recommended for MWDs with penetrating injuries. A clinical management algorithm for MWDs with abdominal trauma is provided. (See Figure 38).

Physical Exam Finding Supporting Abdominal Trauma

Suspect significant intra-abdominal injury in any MWD that presents with abdominal rigidity or sensitivity to palpation, increasing abdominal size over time, visible bruising of the abdominal wall, or failure to respond to or deterioration in face of aggressive trauma resuscitation. Wounds involving more than the skin and superficial subcutaneous tissues dictate detailed examination to determine if the body wall was penetrated, and may require surgical exploration.

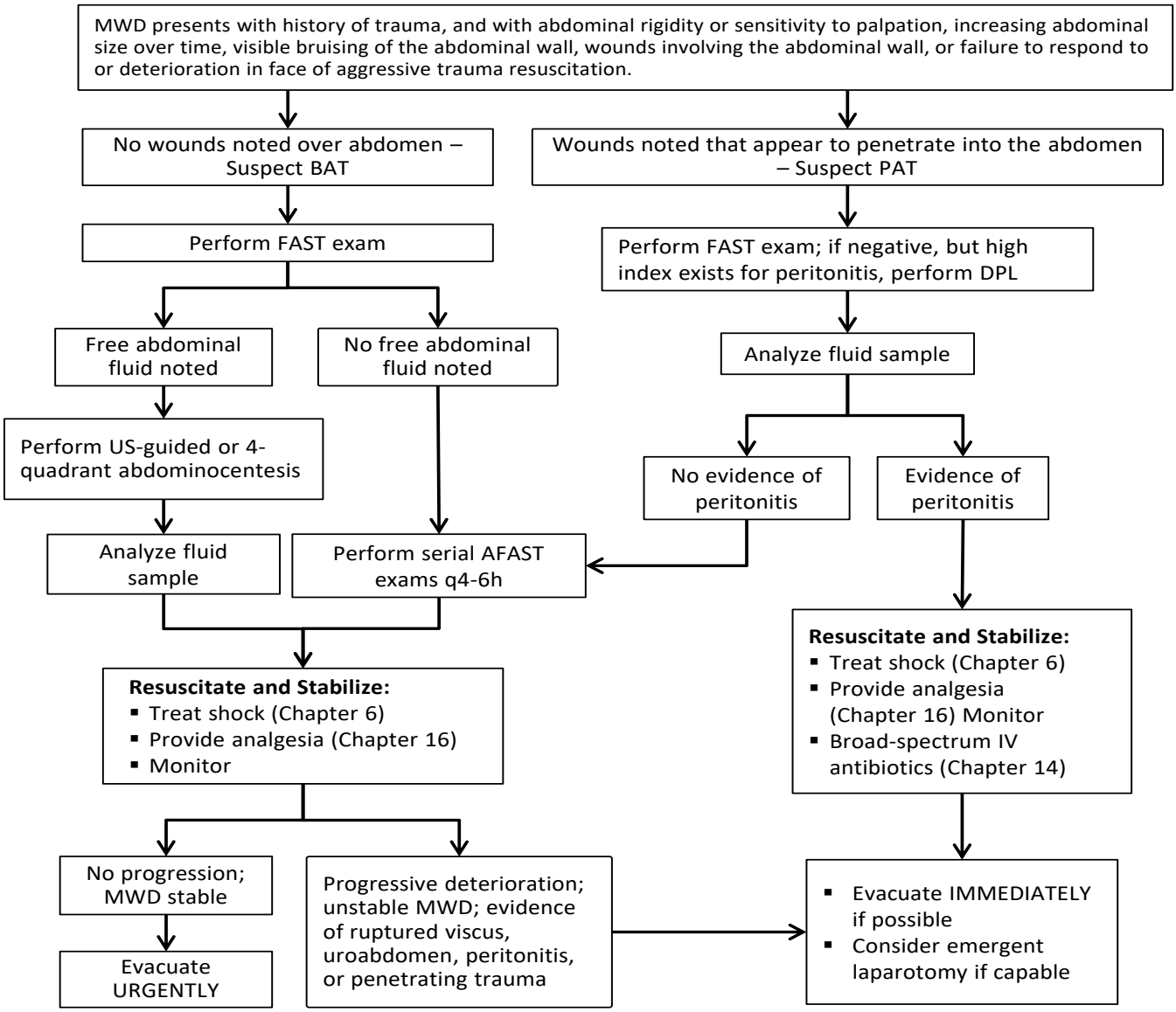
Diagnosis of Abdominal Trauma

The diagnostic method of choice for evaluating patients with suspected blunt abdominal trauma is the abdominal FAST (AFAST) exam, with ultrasound-guided or 4-quadrant needle abdominocentesis if free abdominal fluid is noted. Consider CT if advanced imaging is available.

Perform an AFAST exam during the initial evaluation phase of every MWD with a history of trauma, acute collapse, or weakness. FAST is proven in dogs to be extremely reliable in detecting free abdominal fluid and can be performed rapidly during resuscitation.[8]

- Examine 4 quadrants. Probe placement for dogs includes the diaphragmatic-hepatic site (DH) caudal to the liver, the splenorenal site (SR) around the left kidney, the cystocolic site (CC) cranial to the urinary bladder, and the hepatorenal site (HR) around the right kidney.[8] Figure 39 on page 51 provides a schematic showing probe placement in dogs. Fan the probe in the cranial-caudal and lateral-medial planes.

Figure 38. Clinical Management Algorithm for MWDs with Abdominal Trauma.



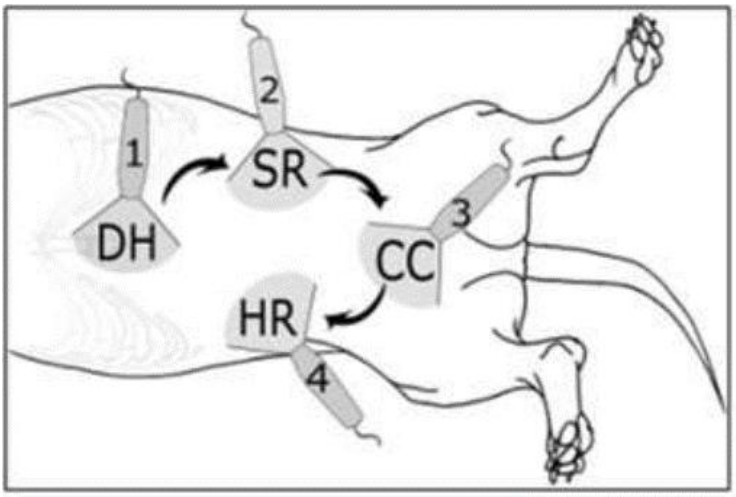


Figure 39. Imaging Locations for AFAST.

Figure 39 shows ultrasound probe placement sites for AFAST scanning of dogs. The dog's head is to the left; the dog is in right lateral recumbency.

DH = diaphragmatic-hepatic

SR = splenorenal

CC = cystocolic

HR = hepatorenal

- Score the AFAST exam, with 1 point for each quadrant that has free fluid identified. Perform serial FAST exams every 4-6 hours and compare scores. MWDs with increasing scores should be monitored closely and prepared for URGENT evacuation or surgery, as exploratory surgery may be necessary for MWDs with scores of 3/4 or 4/4[8] or with clinical deterioration.

Perform a 4-quadrant abdominocentesis in any patient with free fluid in the abdomen.[9] This technique is quick and easy to perform, and usually differentiates abdominal hemorrhage or biliary or urinary tract injury. The general rule of thumb is that a positive peritoneal tap is a reliable indicator that some hemorrhage has occurred or that free urine or bile is in the abdominal cavity, but that a negative tap does not rule these out.

- Place the dog in lateral recumbency. Clip the abdomen of hair and prepare for aseptic procedure.
- "Divide" the abdomen into 4 quadrants, and tap each quadrant sequentially, unless a positive yield is obtained in a quadrant. Perform abdominocentesis on the "down" quadrants, rolling the dog over for the opposite quadrants.
- A large bore needle (18 or 20 gauge) is quickly inserted perpendicular to and through the body wall approximately 2 inches off the midline in each quadrant. Alternatively, a large bore over-the-needle catheter can be aseptically fenestrated and inserted into the abdomen. This increases the likelihood for higher yield because the fenestrations are less likely to occlude.
- The presence of blood suggests intra-abdominal hemorrhage, and the presence of clear or yellowish fluid suggests urine.
- As much sample is collected by gravity drip or slight suction with a 3 cc syringe and saved in serum tubes and EDTA tube. The fluid is analyzed cytologically, and for glucose, lactate, hematocrit, total protein concentration, BUN or creatinine, bilirubin, amylase or lipase, ALT, and ALKP.
  - Assess cytology for the presence of bacteria or other organisms, or fecal or food material that would suggest gastrointestinal rupture and contamination.
  - The peritoneal fluid glucose and lactate concentrations can be measured and compared to serum levels to aid in differentiating possible septic peritonitis in the absence of cytological evidence. An increased abdominal fluid lactate >2.5 mmol/L or an abdominal fluid-to-peripheral blood lactate

difference of >2 mmol/L strongly suggests a septic peritonitis.[10,11] An abdominal fluid glucose concentration that is >20 mg/dL lower than peripheral blood glucose concentration strongly suggests a septic peritonitis.[10,11]

- The hematocrit and total protein concentration are compared to a simultaneously collected peripheral blood sample. If the hematocrit and total protein concentration are similar, significant hemorrhage into the abdomen is probable, and surgical intervention may be necessary, but base this decision on the patient's status more than the actual number. If the hematocrit and total protein concentration of the abdominal fluid are very low, minor hemorrhage is more likely, and a more conservative approach – based on the patient's status – is recommended.

- The presence of bilirubin suggests gall bladder injury, although this may not be present for several days after trauma.[9] Amylase or lipase with values higher than systemic circulation suggests pancreatic trauma. A ratio of 1.4:1 in comparing abdominal fluid potassium with peripheral blood potassium concentrations has 100% sensitivity and specificity for uroperitoneum.[12] Comparison of abdominal fluid creatinine to peripheral blood creatinine concentrations shows 86% sensitivity and 100% specificity for ratios >2:1.[12] Elevated ALT suggests direct liver injury, and elevated ALKP suggests bowel injury or ischemia, but these are non-specific and can rarely be used to guide management decisions.

Consider diagnostic peritoneal lavage (DPL) in any MWD in which major abdominal trauma is suspected, but AFAST and abdominocentesis are unrewarding.[9] If available, CT or MRI may be better modalities.

- Use a specialized DPL catheter or aseptically fenestrate a large bore over-the-needle (OTN) catheter.
- Sedate the patient if necessary and locally anesthetize the site of catheter insertion using 20 mg lidocaine.
- Percutaneously insert the catheter; a small stab incision may be needed if a larger catheter is used.
- Immediately after entering the abdominal cavity, remove the needle and advance the catheter in a caudodorsal direction to avoid the omentum and cranial abdominal organs.
- Infuse 20 mL/kg warmed, sterile saline aseptically over 5-10 minutes.
- Aseptically plug the catheter and gently roll the MWD from side to side for several minutes to allow the infusate to mix.
- Either aspirate effluent or allow gravity-dependent drainage to collect a sample for analysis.
- Analyze the sample for the same parameters described for abdominocentesis.

Blunt Abdominal Trauma (BAT)

The usual organs in MWDs subjected to blunt trauma are the spleen, liver, and urinary bladder, in this order of frequency. Splenic and hepatic injuries are usually fractures of the organ; major vessel trauma is uncommon.[1-7]

- Intra-abdominal hemorrhage. Most hemoperitoneum cases in MWDs are due to splenic and hepatic fractures, which can vary markedly in size, with a significant difference in quantity of blood lost into the abdomen.

- The majority of MWDs with BAT and intra-abdominal hemorrhage that survive to admission can be successfully managed conservatively, since most of the time the source of hemorrhage is small liver and splenic fractures. These usually will spontaneously cease bleeding given time and conservative fluid therapy. Monitor the MWD closely, as some will require exploratory laparotomy and surgical correction of hemorrhage, especially those that do not respond or deteriorate.
- Given the difficulty in maintaining an abdominal counterpressure bandage, and the risk of respiratory compromise, do not apply an abdominal counterpressure bandage on a MWD.
- Patients with massive intra-abdominal bleeding need surgery to find the site of bleeding and surgically correct the loss of blood. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter for guidance.

- Urinary tract trauma. Urinary bladder rupture, with uroperitoneum, is fairly common, especially if the animal had not voided before the trauma.
  - MWDs with acute urologic trauma and uroperitoneum should be stabilized for other injuries, and aggressively managed for shock. Primary repair of a ruptured urinary bladder or other urologic injury must wait until the patient stabilizes to minimize the risk of complications associated with taking an unstable patient to surgery.
  - In many cases, urologic injury is not apparent for several days after trauma, so a high index of suspicion must be maintained. Special studies (ultrasound, excretory urography, contrast urethrocystography) may need to be performed to rule out urologic trauma.
  - In patients with known urologic tears and urine leakage, abdominal drains may be indicated if surgery is delayed for several days while the patient stabilizes. This will allow removal of urine, which will minimize chemical peritonitis and electrolyte and acid-base imbalances (metabolic acidosis, hyperkalemia). Intensive fluid therapy to correct or prevent electrolyte and acid-base imbalances is often necessary, especially if several days have passed since traumatic injury.
  - Surgical repair must only be performed after the patient is stabilized. Patients with severe uroabdomen need surgery to define the extent of injury and correct the problem. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter.
- Ruptured abdominal viscus. Patients with a ruptured gastrointestinal viscus are candidates for emergent exploratory surgery to identify the part of the tract that is injured and allow primary repair. Delay in repairing bowel perforation can rapidly lead to septic peritonitis, septic shock, and rapid patient deterioration.[13]

TABLE 11. ANTIBIOTIC SELECTION AND DOSING FOR MWDS			
ANTIBIOTIC	**DOSE FOR MWD**	**ROUTE**	**FREQUENCY**
Amoxicillin-Clavulanic Acid	13.75 mg/kg	PO	q 12 h
Ampicillin Sulbactam	20 – 30 mg/kg	IV q	8 h
Cefazolin	20 -30 mg/kg	IV q	8 h
Cefotaxime	22 mg/kg	IV q	8 h
Ceftriaxone	25 mg/kg	IV q	8-12 h
Cephalexin	20 – 30 mg/kg	PO q	12 h

- Broad-spectrum antibiotic therapy is vital, especially against anaerobic and gram negative bacteria. Table 11 lists antibiotic options for initial use in MWDs with ruptured viscus or septic peritonitis.
- Shock management is of special importance. Every attempt must be made to stabilize the patient as much as possible, with URGENT evacuation to a veterinary facility for definitive repair.
- Patients with ruptured abdominal viscus need surgery to define the extent of injury and correct the problem. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter for guidance.

Penetrating Abdominal Trauma

Exploratory laparotomy as a diagnostic and therapeutic modality is clearly indicated in trauma patients if penetrating trauma is highly suspected or known, or if the patient's status deteriorates despite aggressive resuscitation attempts and major organ hemorrhage or injury is suspected or known.[13]

- Non-invasive diagnostic imaging is recommended in an attempt to confirm a suspicion of major internal organ injury. Perform AFAST, abdominocentesis, and/or DPL as necessary, and advanced imaging if available.
- Patients with penetrating abdominal injuries and a high index of suspicion for peritonitis, bowel injury, ruptured viscus, major hemorrhage, or other life-threatening problem need emergent surgery to further define the extent of injury and provide corrective surgery. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter for guidance. Empiric antibiotic therapy is critical (See Table 11).

Emergent Abdominal Laparotomy

Some patients with severe abdominal trauma require surgery to define the extent of injury and attempt repair of the problem, remembering the caveats discussed previously.[13]

- Surgical management includes an approach through the ventral midline under general anesthesia with the dog in dorsal recumbency, to expose the abdominal cavity.

- A complete abdominal exploratory is necessary to define all injuries. Routine exploratory techniques used for people are appropriate for dogs.
- Surgical management will depend on the injuries noted. Expect hemoabdomen, liver and spleen trauma with hemorrhage, major vessel injuries with hemorrhage, bowel perforation, hollow viscus injuries, urinary tract injuries, and abdominal wall injuries. Repair of injuries in the dog is essentially the same as repair in human casualties.
- Abdominal wall closure is in 3 layers: 0 non-absorbable simple interrupted linea alba closure; 2-0 absorbable simple continuous subcutaneous closure; routine skin closure.

Abdominal Trauma References

1. Kolata RJ, Kraut NH, Johnston DE. Patterns of trauma in urban dogs and cats: A study of 1000 cases. J Am Vet Med Assoc 1974;164:499-503.
2. Kolata RJ, Johnston DE. Motor vehicle accidents in urban dogs: A study of 600 cases. J Am Vet Med Assoc 1975;167:938-941.
3. Simpson SA, Syring RS, Otto CM. Severe blunt trauma in dogs: 235 cases (1997-2003). J Vet Emerg Crit Care 2009;19:588-602.
4. Merck MD, Miller DM, Reisman RW, et al. Blunt Force Trauma. In: Veterinary Forensics: Animal Cruelty Investigations. Somerset: Wiley, 2012:97-120.
5. Culp WTN, Silverstein DC. Thoracic and abdominal trauma. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;728-733.
6. Ressel L, Hetzel U, Ricci E. Blunt force trauma in veterinary forensic pathology. Vet Pathol 2016;53:941-961.
7. Intarapanich NP, McCobb EC, Reisman RW, et al. Characterization and comparison of injuries caused by accidental and non-accidental blunt force trauma in dogs and cats. J Forensic Sci 2016;61:993-999.
8. Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of an abdominal fluid scoring (AFS) system determined using abdominal focused assessment with sonography for trauma (AFAST) in 101 dogs with motor vehicle trauma. J Vet Emerg Crit Care 2009;19:426-437.
9. Jandrey KE. Abdominocentesis and diagnostic peritoneal lavage. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;1036-1039.
10. Bonczynski JJ, Ludwig LL, Barton LJ, et al. Comparison of peritoneal fluid and peripheral blood pH, bicarbonate, glucose, and lactate concentrations as a diagnostic tool for septic peritonitis in dogs and cats. Vet Surg 2003;32:161-166.
11. Levin GM, Bonczynski JJ, Ludwig LL, et al. Lactate as a diagnostic test for septic peritoneal effusions in dogs and cats. J Am Anim Hosp Assoc 2004;40:364-371.
12. Schmiedt CW, Tobias KM, Otto CM. Evaluation on abdominal fluid:peripheral blood creatinine and potassium ratios for diagnosis of uroperitoneum in dogs. J Vet Emerg Crit Care 2001;11:275-280.
13. Volk SW. Peritonitis. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;643-648.

CHAPTER 8

Gastrointestinal Emergencies

Among other gastrointestinal emergencies, MWDs are at increased risk for development of two life-threatening gastrointestinal emergencies: Gastric Dilatation-Volvulus Syndrome, and mesenteric volvulus.[1-3]

Gastric Dilation-Volvulus Syndrome (GDV or “bloat”)

GDV is a multifactorial, rapidly progressing, life-threatening surgical emergency common in large-breed dogs, to include MWDs.[4] In GDV, the stomach rapidly dilates (gastric dilation) with fluid, food, and air, and then rotates along the long axis (volvulus). When volvulus develops, the esophagus and duodenum become twisted, preventing passage of stomach contents. The amount of air, food, and fluid that accumulates is dramatic and progressively worsens – typically over 30 minutes to 4 hours – and causes shock by interfering with venous return from the abdomen and pelvic limbs. Death in cases of GDV in the short-term is due to shock. Death in the long-term is due to gastric wall necrosis and rupture with secondary sepsis, DIC, or cardiac arrhythmias.[4-5]

Most MWDs have had a prophylactic gastropexy performed before deployment. This elective surgical procedure creates a surgical adhesion between the stomach and the inner abdominal wall that is very effective at preventing volvulus. While gastric dilation (GD) can still occur, this in and of itself is seldom severe enough to cause shock, since accumulated gas and stomach contents can be vomited or passed into the bowel. However, HCPs should recognize that many deployed working dogs operated by Allied military forces and DoD contractors likely have not been gastropexied, and – in rare cases – a gastropexy can fail, and GDV must be a differential in dogs with typical signs.

Clinical Signs of GDV

GDV patients classically present with a constellation of clinical signs that should prompt immediate evaluation. MWD handlers are trained to recognize these signs, and handlers may have performed emergency care before the dog is presented to a MTF, to include gastric decompression.

Early signs of GDV include varying degrees of abdominal distention (tympany) from stomach filling with air, food, and fluid; nonproductive retching, attempted vomiting without result, or retching a small amount of saliva ("dry heaves"); signs of pain (grunting, especially when the stomach or abdomen is palpated); signs of anxiety, which is commonly noted as pacing, anxious stares, and inability to get comfortable when lying down; and signs of compensatory shock (tachycardia, tachypnea).

As GDV progresses, clinical signs of advancing shock ensue. MWDs may present at any time in the continuum of the syndrome, and often present *in extremis* if recognition or care has been delayed.

HCPs should assume GDV is present and take immediate action if an MWD presents with signs of shock, abdominal distension, non-productive vomiting or retching, and signs of anxiety or pain.

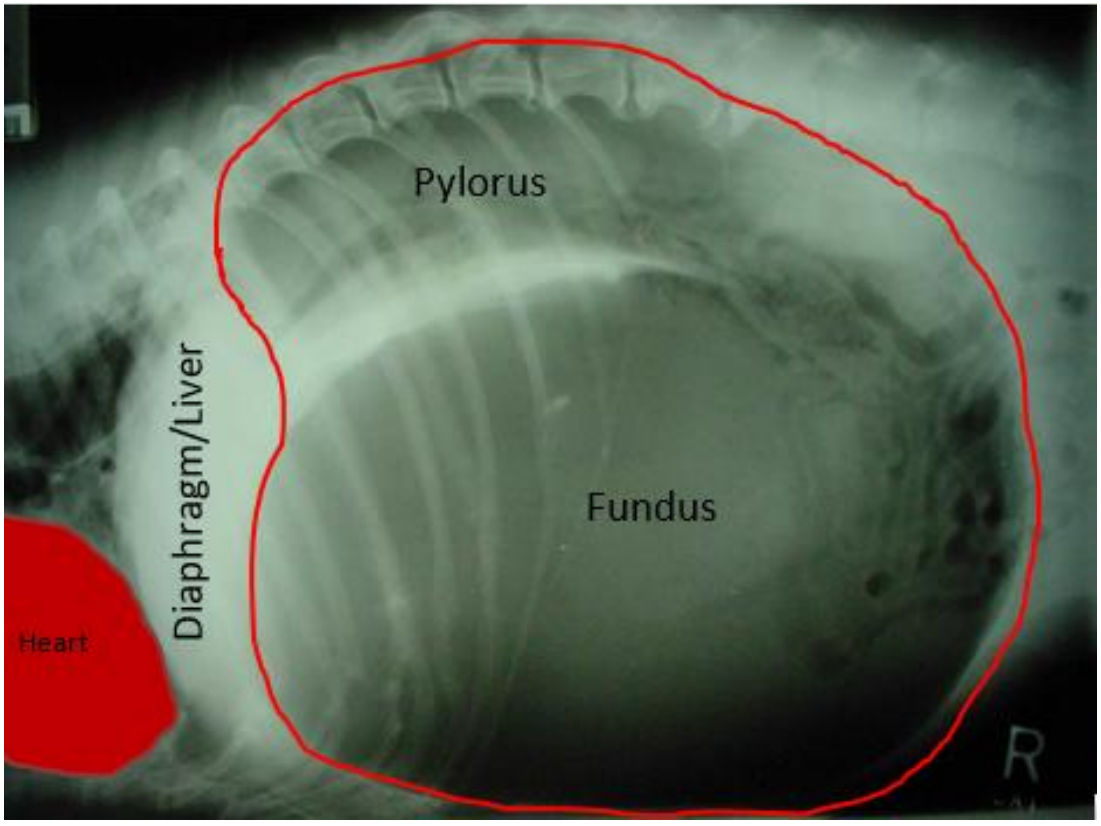
Definitive Diagnosis of GDV

Confirmation of GDV is based on abdominal radiographs that demonstrate marked gastric dilation with air (See Figure 40). Radiography, if available, is recommended if there is doubt about the diagnosis, as other conditions (e.g., hemoperitoneum, abdominal neoplasia, ascites) mimic some of the signs of GDV. Generally, a single right lateral radiograph is sufficient.

Management of GDV

A management algorithm is provided (See Figure 41). The hallmark immediate treatment of GDV includes rapid decompression of gas from the dilated stomach, shock therapy, monitoring for complications, repeated decompression if dilation recurs, and rapid evacuation to veterinary facilities for definitive surgery. GDV is a surgical emergency; surgery is required to derotate the stomach and perform gastropexy, and to perform partial gastric resection or splenectomy if warranted, with extended monitoring for common life-threatening sequellae in the post-operative period.

Figure 40. Radiograph with Gastric Dilation Volvulus.
Figure 40 shows a right lateral radiograph of a dog with marked gastric dilation due to GDV. Head is to left. Red line depicts general outline of the massively distended stomach, with the pylorus malpositioned dorsal to the fundus.



GDV Management Summary

- **Treat shock.** Provide 100% oxygen (See Chapter 4). Administer intravenous fluids to targeted endpoints (See Chapter 6, Figure 33).
- **Decompress the stomach by percutaneous trocarization of the stomach:**
- Position yourself on the left side of the patient, or lay the dog with its left side down (left lateral recumbency).
- **Locate the insertion point:**
  - Palpate the last rib.
  - Move the hand 2 inches caudal to the last rib, midway between the spine and the ventral border of the abdomen on the right side.
  - Auscult the lateral abdominal wall at the most distended area while percussing (flicking) the abdominal wall firmly with a finger. This percussion will elicit a "pinging" sound, and the site of insertion of the trocar should be at the point of loudest "pinging."
- Clip the hair over a 6-inch X 6-inch area over this area. Prepare the area using surgical scrub.
- Forcefully insert a 10-14 gauge trocar or 14-18 gauge IV over-the-needle catheter through the skin, abdominal wall, and stomach wall. Note gas or air escaping through the trocar/needle from the stomach to signify a successful trocarization.
- Note: If no air or gas is coming from the trocar, attempt gastric trocarization one more time. If still unsuccessful, do not attempt any further trocarizations. Emergent surgery is indicated if trocarisation is not possible.
- Gently apply external pressure to the abdominal wall to assist in decompressing air from the stomach.
- Once the majority of the air is evacuated, remove the trocar/needle, because leaving it inserted may cause trauma to internal organs.

Common Complications Associated with GDV

Monitor for the most common complications seen in MWDs with GDV, to include ventricular arrhythmias, persistent shock, recurrent gastric dilation, nausea and vomiting, ileus, electrolyte abnormalities (especially potassium), and metabolic acidosis. Multi-organ failure may develop, depending on the degree and duration of shock.

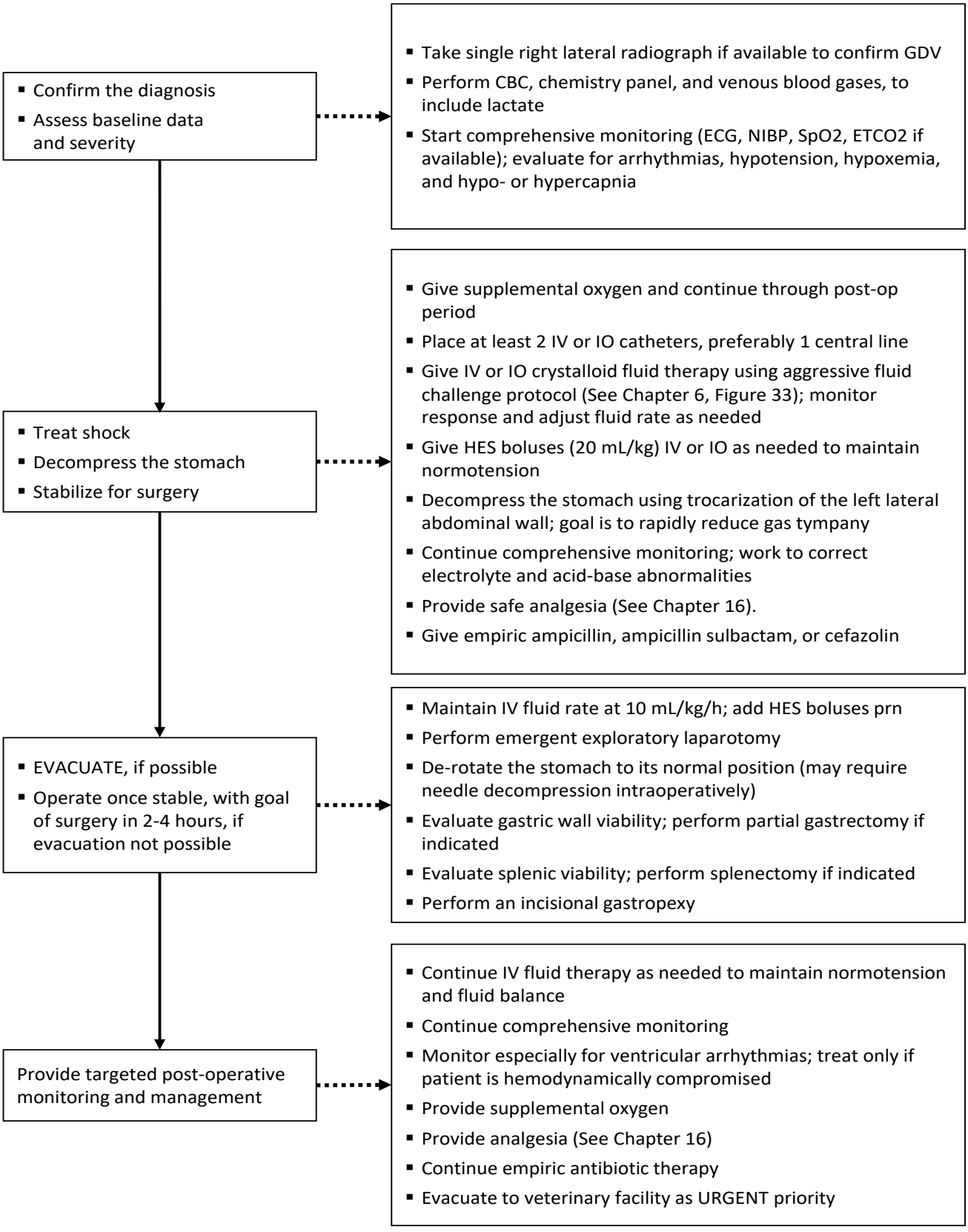
Definitive Surgical Management of GDV

Evacuate the MWD to a veterinary facility as soon as it is stabilized. Any MWD with GDV should be considered an URGENT casualty. Definitive surgical management – consisting of exploratory laparotomy, derotation of the stomach, gastropexy, and possible partial gastric resection and/or splenectomy – requires trained personnel intimate with the anatomy and physiology of the dog.

Emergency surgical exploration of the abdomen and attempted surgical management of GDV by HCPs in the deployed setting may be necessary if evacuation will be delayed more than 4-6 hours.

- It is essential to counter shock and stabilize the dog before considering operative management.
- Surgical management includes an approach through the ventral midline under general anesthesia, with the dog in dorsal recumbency, to expose the abdominal cavity (See Chapter 16.)
- GDV is confirmed once the abdomen is open by identifying a dilated stomach covered by omentum.
- The stomach is de-rotated to its normal position by grasping the stomach on both extreme lateral aspects simultaneously, and rotating the stomach counterclockwise (when viewed from the dog's right side in dorsal recumbency).
- A markedly tympanic stomach may need to be further decompressed by intraoperative needle decompression with suction to allow adequate manipulation.
- Typically, the gastric wall has variable degrees of bruising, especially at the cardia, and may have developed partial- or full-thickness necrosis. If bruising persists or worsens intraoperatively, or if gastric wall necrosis is suspected, perform a partial gastrectomy of suspect gastric wall. Gastrectomy is ideally performed using TA or GIA surgical stapling equipment or an inverting double-layer gastric wall suture pattern of non-absorbable suture. Note that postoperative mortality in dogs that require gastrectomy is approximately 25 -35%, compared to mortality <10% in dogs that do not require gastrectomy.
- Typically, intra-abdominal bleeding is encountered due to rupture of the short gastric arteries and/or splenic injury. Assess the viability of the spleen and perform splenectomy if splenic thrombosis, marked splenic vessel injury and bleeding, or splenic lacerations are noted. Arcade ligation, with special attention to the major splenic vessels, is optimal, and is best done with LDS stapling equipment (for vessels <4 mm diameter) and suture ligation (for vessels >4 mm diameter) using transfixation sutures.
- Perform an incisional gastropexy (to prevent future GDV). Create a 3-4 cm incision in the seromuscular layer of the right pyloric area of the stomach wall. Create a similarly-sized incision in the right ventrolateral abdominal wall musculature. Appose the margins of the gastric wall incision against the margins of the incision in the abdominal wall musculature and create a gastropexy by suturing each margin using 0 or 2-0 non-absorbable suture.
- Abdominal wall closure is in 3 layers: 0 non-absorbable simple interrupted linea alba closure; 2-0 absorbable simple continuous subcutaneous closure; routine skin closure.

Figure 41. Clinical Management Algorithm for Gastric Dilatation-Volvulus (GDV) in Military Working Dogs.



Mesenteric Volvulus

Mesenteric volvulus (MV) is a rapidly progressive and often fatal condition in which intestinal rotation develops around the root of the mesentery. Although rare, it appears to be increasing in frequency in MWDs.[3] The case fatality rate was 92% in a recent report of 54 MWDs with MV; of these 24% were found dead and 76% were identified antemortem, and only 14% of the 126 reported cases have survived.[3] Rapid recognition is necessary to afford MWDs a chance at survival.

- In MV, the cranial mesenteric blood vessels and branches obstruct due to rotation, causing ischemic necrosis of the aborad duodenum, all the jejunum, ileum and cecum, ascending and transverse colon, and orad descending colon.
- Death is due to rapidly progressive vascular obstruction, intestinal anoxia, shock, endotoxemia, and cardiovascular failure.[3]
- Statistical analysis of MV in 54 MWDs[3] suggests key risk factors include German shepherd breed, age, prophylactic gastropexy or other abdominal surgery, history of gastrointestinal disease, use of nonsteroidal anti-inflammatory drugs, and increased humidity on the day of occurrence.

Clinical Signs and Imaging Findings Suggesting MV

- Peracute-to-acute onset of vomiting, mild abdominal distension, and shock.
- Hemorrhagic diarrhea with or without tenesmus.
- Intense abdominal pain on palpation.
- Rapidly progressive deterioration in clinical presentation.
- Extreme gas distension of the majority of the small and large bowel (See Figure 42 below).

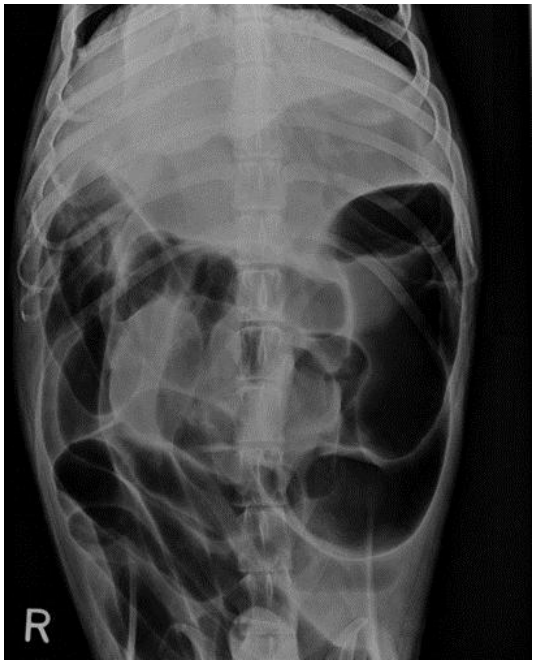
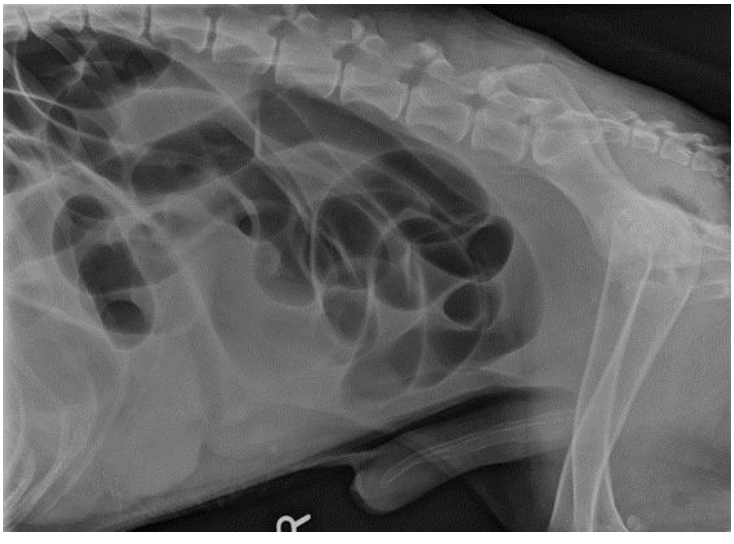


Figure 42. Lateral and ventrodorsal abdominal radiographs of a dog with MV, demonstrating near complete and severe gas distension of the entire bowel.



Emergent Management of MV

MV is a true surgical emergency. The hallmark immediate treatment of MV includes rapid assessment and determination of the need for emergent abdominal surgery, and aggressive shock therapy – err on the side of emergent abdominal laparotomy if clinical signs and imaging suggest MV. It is unlikely the dog can be evacuated soon enough to veterinary facilities, so be prepared to operate in the MTF. Extended monitoring for common life-threatening sequellae is required in the post-operative period.

Treat shock:

- Provide 100% oxygen (See Chapter 4).
- Administer intravenous fluids to targeted endpoints (See Chapter 6, Figure 33).

Perform emergent exploratory laparotomy:

- It is essential to begin to counter shock as you prepare for surgery.
- Surgical goals are to confirm the diagnosis, determine surgical options, and assess prognosis.
- Surgical management includes an approach through the ventral midline under general anesthesia (See Chapter 16), with the dog in dorsal recumbency, to expose the abdominal cavity.
- Operative management by resection and anastomosis should only be considered if the following conditions are met:
  - The duodenum is intact in its entirety;
  - At least 2cm of healthy ileum is present;
  - At least 50% of the jejunum is assessed to be viable;
  - No large bowel is affected.
- Abdominal wall closure is in 3 layers: 0 non-absorbable simple interrupted linea alba closure; 2-0 absorbable simple continuous subcutaneous closure; routine skin closure.

Euthanasia should be considered for an MWD presenting in extremis, or in dogs that fail to respond to therapy, that deteriorate despite care, or in which operative management is not feasible (See Chapter 21).

Common Complications Associated with MV

Monitor for the most common complications seen in MWDs with MV, to include ventricular arrhythmias, persistent shock, septic peritonitis, nausea and vomiting, ileus, and metabolic acidosis. Multi-organ failure may develop, depending on the degree and duration of shock.

Gastrointestinal Emergencies References

1. Evans RI, Herbold JR, Bradshaw BS, et al. Causes for discharge of military working dogs from service: 268 cases (2000-2004). J Am Vet Med Assoc 2007;231:1215-1220.
2. Moore GE, Burkman KD, Carter MN, et al. Causes of death or reasons for euthanasia in military working dogs: 927 cases (1993-1996). J Am Vet Med Assoc 2001;219:209-214.
3. Andrews SJ, Thomas TM, Hauptman JG, Stanley BJ. Identification of risk factors for mesenteric volvulus in military working dogs: A case control study, 54 case (1990-2014). J Am Vet Med Assoc, in press, 2018.
4. Sharp CR. Gastric Dilatation-Volvulus. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;649-653.
5. Beck JJ, Staatz AJ, Pelsue DH, et al. Risk factors associated with short-term outcome and development of perioperative complications in dogs undergoing surgery because of gastric dilatation-volvulus: 166 cases (1992–2003). J Am Vet Med Assoc 2006;229:1934-1939.

CHAPTER 9

Heat Injury

The Heat Injury chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

Hypothermia and Cold Injuries

Hypothermia and Cold Injuries is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 11

Snake and Insect Envenomation

The Snake and Insect Envenomation chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 12

Blast, Burn and Crush Injuries

The Blast, Burn and Crush Injuries chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

Long Bone Fractures

General Considerations

- Recognize and manage life-threatening problems FIRST. Fractures and muscle, tendon, or ligament injuries are rarely life threatening. Resuscitate and stabilize life-threatening problems first. Provide treatment to prevent further compromise to the fracture site and neurovascular structures and minimize infection risk.
- Recognize long bone fractures. MWDs with fractures will have varying degrees of lameness and will likely have limb deformity, swelling, pain, and loss of function. Open fractures are generally obvious, but pose greater risk of local and systemic infection and loss of function. See **Management of Open Fractures** in this chapter for specific guidance.
- Provide analgesia and confine the MWD. Any MWD with possible fractures or joint injury should initially be given parenteral analgesia, continued orally once stabilized (See Chapter 16). Any MWD with possible fractures should be confined to its kennel or small space at all times, with limited opportunities to go outside to urinate and defecate (three times daily as a minimum). Use a make-shift sling placed under the abdomen while walking patients outside. Analgesia and confinement may be the only treatment necessary or feasible, as noted below.

Long Bone Fractures and Joint Abnormalities of the Lower Limbs

HCPs should stabilize any suspected fracture or joint abnormality of the long bones distal to the elbow and knee (radius/ulna, tibia/fibula).

- Manage wounds as per Chapter 14 and then apply splints (e.g., SAM splints) to immobilize the fracture site, ensuring the joints above and below the fracture site are immobilized. Apply buttresses made of layers of cast padding or non-adherent dressing around footpads and any wounds. Apply about twice as much cast padding as is used for people. Generally, it is best to leave the nails of the middle two toes exposed, to allow monitoring for swelling.
- Cast application is not recommended, as cast pressure or friction sores are extremely common with MWDs and complicate recovery. MWDs tolerate splints and bandages poorly, so any MWD with a bandage or splint applied must wear a device to prevent self-mutilation or bandage removal (See Figure 21 and Figure 22).
- Splints and bandages generally need to be changed at least every other day. Change more frequently if soiled, wet, or loose.

Long Bone Fractures and Joint Abnormalities of the Upper Limbs

In MWDs, fractures of these bones are very difficult to immobilize, splints and bandages are poorly tolerated, and splints and bandages can actually increase fracture displacement, worsen fractures, and jeopardize neurovascular bundles. Key management principles are to provide adequate analgesia (See Chapter 16) and minimize movement to the maximal extent (kennel confinement except for limited leashed walks, using ancillary support).

- **HCPs without advanced orthopedic training and experience** generally should not attempt to immobilize fractures of the humerus, scapula, or femur.[1,2]
- **HCPs with advanced training and experience in orthopedics** (typically orthopedic surgeons, orthopedic PAs, splint technicians in Level 2 or higher facilities) may be capable, with written and/or verbal guidance from supporting veterinarians in constructing an appropriate Spica splint for humerus and femur fractures. In these instances, appropriate coaptation is safe, makes the patient more comfortable and consequently makes it easier and safer to transport a wounded MWD. With appropriate coaptation, the MWD is less likely to become agitated or aggressive every time it is bumped, moved, or moves about during manipulation and transport.

Open Fractures

Proper management of open fractures is essential. Open fractures should be treated as a medical emergency, once more pressing problems are addressed (See Table 17).[1,2]

Initial management of open fractures during resuscitation. While evaluating the entire patient and initiating life-saving therapy, take measures to protect the open fracture site:

- Do not attempt to reduce bone(s) protruding at fracture sites, as this drags contamination to the fracture site and may cause injury to the neurovascular bundle.
- Quickly remove any large gross contaminants from the wound (e.g., leaves, rocks, stick fragments), but do not attempt to clip the hair or cleanse the wound at this point.
- Cover the fracture and wound with sterile non-adherent dressing and apply a light bandage. This bandage should not be placed in an attempt to stabilize or immobilize the fracture at this time; it is simply to protect the open wounds and exposed bone from further contamination during initial patient resuscitation.

Specific management recommendations for open fractures. MWDs with open fractures generally will require surgical correction of the fracture once evacuated to veterinary facilities. The overriding aims are to prevent bacterial infection and promote normal healing.

- Culture open fracture sites as soon as possible after presentation and before antibiotic use if possible.
- Administer antibiotics as per Table 19 in Chapter 14, focusing on use of intravenous antibiotics based on

(Continued on page 93)

likely contaminants. Never withhold antibiotic therapy in any patient with an open fracture.

- Address pain with appropriate analgesic therapy (See Chapter 16). Reassess pain every 4-6 hours.
- Manage soft tissue injuries over the fracture site appropriately, as proper management of the wound postures the patient for successful outcome. See Chapter 14 for wound management recommendations.
- After appropriate wound care, apply a sterile moisture-retentive bandage over open fractures, as it is important to keep soft tissues and bone moist for optimal healing. Change bandages at least once daily, based on degree of strike-through, soiling, or loosening.

TABLE 17. MANAGEMENT OF LONG BONE FRACTURES IN MWDS[1,2]

1. Address life-threatening problems first!

During resuscitation, protect any open fractures.

- Do not attempt to reduce bones protruding at the fracture site.
- Remove any large gross contaminants from the wound, such as leaves, rocks, or stick fragments, but do not clip hair or cleanse the wound at this point.
- Cover the fracture and wound with sterile non-adherent dressing and apply a light protective bandage.

2. LOWER LIMB FRACTURES -- After resuscitation, immobilize fractures or joint abnormalities involving the limbs below the elbow or knee, prevent bacterial infection, provide analgesia, and promote normal healing until definitive surgical repair.

- Culture any open fracture sites as soon as possible, and before antibiotic use if possible.
- Administer antibiotics as directed in Chapter 14 for open fractures.
- Manage any open wounds over the fracture site as per Chapter 14.
- Provide analgesia as directed in Chapter 16. Reassess pain every 4-6 hours.
- Apply splints or heavy bandages to immobilize the fracture site, ensuring the joints above and below the fracture site are immobilized.

3. UPPER LIMB FRACTURES – After resuscitation, minimize further injury to fractures of the limbs above the elbow or knee.

- Culture any open fracture sites as soon as possible, and before antibiotic use if possible.
- Administer antibiotics as directed in Chapter 14 for open fractures.
- Manage any open wounds over the fracture site as per Chapter 14.
- Provide analgesia as directed in Chapter 16. Reassess pain every 4-6 hours.
- Unless experienced in external coaptation, DO NOT apply splints or heavy bandages, as these are poorly tolerated by MWDs and will increase the risk of displacement and further injury to the neurovascular bundle.
- Confine the MWD to a kennel or small space; limit walks; and support as needed when walked.

4. Monitor MWDs with fractures.

- Ensure a device is used to prevent self-trauma (See Chapter 2).
- Assess pain frequently and ensure adequate analgesia.
- Change splints or bandages daily (open fractures, wounds, soiled or wet) or every other day (clean and dry splints or bandages that do not cover open fractures or wounds).

- Apply splints and bandages as described previously for open fractures of the radius/ulna or tibia, or lower aspects of the limbs. Confine MWDs with any fracture, but especially with upper limb fractures that cannot be immobilized.

Definitive Long Bone Fracture Repair

Definitive repair should be delayed until the patient can safely undergo anesthesia and surgery performed by veterinary personnel best equipped to manage MWD's post-operatively. There is no role for HCPs to attempt definitive repair of long bone fractures in MWDs. Standard practice human fracture management is to span the fracture with external fixation to stabilize during transport, with definitive repair at a later date. Spanning the fracture is not considered definitive repair, but is not appropriate for MWDs as they will be ambulatory and break the construct. Thus, temporary external skeletal fixation is not indicated in MWD long bone fractures. The goals for HCP care of MWDs are initial management, stabilization, and evacuation to veterinary medical personnel for definitive care.

Pelvic Fractures

Pelvic fractures in MWDs in deployed settings will most likely be due to crush or blast injury (See Chapter 12). Evaluate the pelvis for external evidence of trauma or deformity.

The major joints involving the pelvis are the coxofemoral (hip) and sacroiliac (lower back) joints. Fractures or dislocations of these bones and joints are fairly common. A tip off for joint dislocation is asymmetry. Carefully palpate the hip joints and lower back for swelling, pain, or deformity that suggests joint injury. Move the limbs carefully through their range of motion while palpating the hip area and lower back to evaluate hip luxation.

Trauma to adjacent structures such as the rectum, descending colon, urinary bladder, urethra, and reproductive organs is a concern. Evaluate the inguinal area and external genitalia for evidence of trauma or herniation. Fractures of the pelvic floor commonly cause asymmetry, swelling, and bruising in the inguinal region. Hidden internal injury due to fractures (e.g., urethra, urinary bladder, prostate, vagina) is difficult to detect. Assess neurologic input to the anus by pinching the skin around the anus with hemostatic forceps—the expected response is sudden tightening of the anal sphincter.

Examine external genitalia for trauma. Carefully perform a digital rectal exam with a well-lubricated finger to assess for bleeding and injury to the urogenital structures in the pelvic canal, and to palpate for pelvic fractures.

Manage pelvic fractures by confining the MWD to its kennel or to a small space, limiting movement to short, frequent, handler-controlled leash walks using a towel or other material passed beneath the abdomen to provide support when walking, and adequate analgesia (See Chapter 16).

Long Bone Fracture References

1. Halling K. Wounds and open fractures. In: Mathews K, ed. *Veterinary Emergency and Critical Care Manual.* Guelph, Ontario, Canada: Lifelearn, Inc., 2006;702-708.

2. Tillson MD. Open fracture management. *Vet Clin North Am Small Anim Pract* 1995;1093-1110.

Wound Management

The Wound Management chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 15

Ocular Injuries

The Ocular Injuries chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

Analgesia and Anesthesia

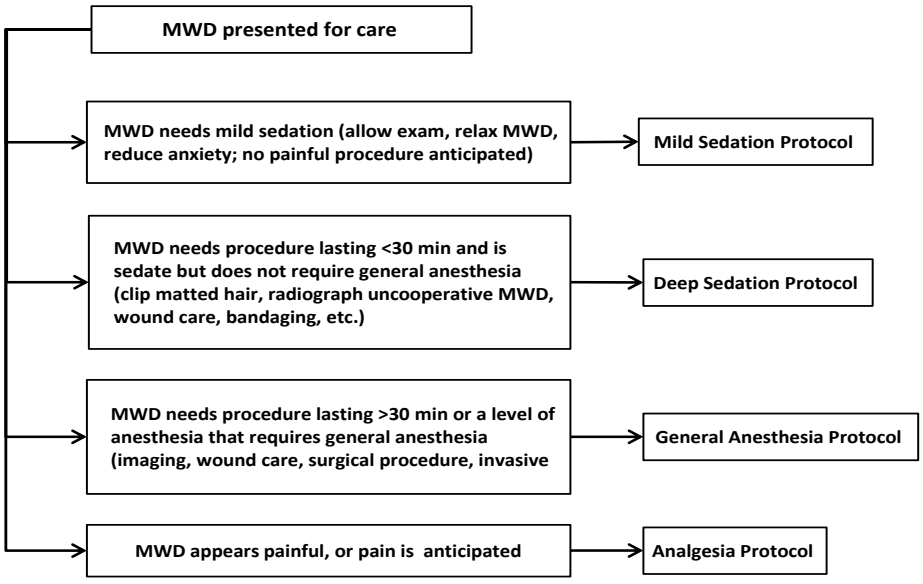
This chapter provides succinct, quick reference protocols for analgesia and anesthesia of emergently ill or injured MWDs, using simple combinations of drugs readily available to most HCPs.[1] A decision-making algorithm is provided below (Figure 45) to determine which analgesia or anesthesia protocol is recommended, based on specific need. Before any use of analgesia or anesthesia, a full physical exam must be performed.

MWDs can be fractious and difficult to manage, and often require heavy sedation for relatively simple procedures. Tailored protocols are provided, based on the level of sedation or anesthesia required – mild or deep sedation, or general anesthesia.[1]

Prehospital Analgesia

MWD handlers or combat medics may have given morphine, fentanyl, or ketamine before arrival, so inquire about drug use before transport, which may affect assessment of the patient's mentation and analgesia.

Figure 45. Decision-making Algorithm for Analgesia or Anesthesia.



Protocol Guidance

All drug combinations use the intramuscular (IM) route for ease and safety. If used within 5 minutes, all drugs can be combined in the same syringe to simplify administration. ***Wait at least 20 minutes after administration before attempting any procedure, to allow maximal drug effect***. Ideally, an IV catheter should be placed once feasible (See Chapter 2).

Drug Dosing in Dogs

Dosages for many analgesics in dogs are significantly higher than for people. Trust the doses provided in this chapter, and dose as directed to prevent inadequate analgesia or sedation and 'wind up' pain.

Gastrointestinal Side Effects of Opioids

Protocols include opioids, which in dogs typically causes emesis, often within 5 minutes of administration. Use caution and have the handler prepared to remove the muzzle to minimize aspiration risk.

Mild Sedation Protocol

- Use to relax MWDs for examination, handling, or short minor procedures that will not cause pain. Use to reduce anxiety.
- **Protocol:** MIDAZOLAM 0.3 mg/kg IM and HYDROMORPHONE 0.2 mg/kg IM.
- **Expectations:** The MWD will be calm, but reactive and noise sensitive.

Deep Sedation Protocol

- Use for procedures that can be completed in <30 minutes and do not require general anesthesia, such as clipping of hair, wound cleansing, minor wound debridement, splinting of lower limb fractures, bandage application or removal, ear cleaning, or radiography. First-line protocol for fractious MWDs.
- **Protocol:** MIDAZOLAM 0.3 mg/kg IM and KETAMINE 5 mg/kg IM and HYDROMORPHONE 0.1 mg/kg IM.
- If deeper sedation or light anesthesia is necessary, or to allow general anesthesia induction, use PROPOFOL in 1 mg/kg boluses IV as needed.
- **Expectations:** The MWD will not be able to walk, cannot be intubated, can be aroused with stimulation, and maintains laryngeal and palpebral reflexes.

General Anesthesia Protocol

- Use to facilitate imaging, allow management of fractures, perform surgical procedures, and perform invasive diagnostic procedures.
- Preoxygenate for 5 minutes using oxygen mask.

- Premedicate using the Deep Sedation Protocol, and place an IV catheter.
- Induce using PROPOFOL 1 mg/kg IV boluses to effect.
- Intubate with an appropriate endotracheal tube. Most MWDs require a 9-11 mm ID endotracheal tube. Use a cuffed tube.
- Maintain anesthesia using ISOFLURANE 0.5-1.5% titrated to effect in 100% oxygen or SEVOFLURANE 2.0-2.5% titrated to effect in 100% oxygen or PROPOFOL CRI 100-300 mcg/kg/min.
- Manage pain with HYDROMORPHONE 0.1 mg/kg IV boluses, not to exceed 0.2 mg/kg per hour.
- Monitor appropriately, give IV fluids, and keep the MWD warm (See **Ancillary Support** in this chapter, and Table 20 on the next page).

Effective Analgesia Protocols for MWDs

Assessment of pain in dogs is difficult. Dogs are generally very stoic and often hide or fail to show outward signs of pain. HCPs should err on side of providing analgesia – if performed properly, it is safe and effective, and analgesia is critically important for safe handling and alleviation of pain.

- Note that all protocols have analgesia incorporated into them. Additional analgesia can be provided by the IV, IM, or PO route, as necessary.
- ***Scheduled administration of analgesics in the post-procedure period is preferred*** to as needed administration in dogs, because pain can be difficult to assess and to avert the 'roller coaster' effect of unmanaged pain.
- For intermittent IV or IM supplementary analgesia, use one of the following drugs:
  - HYDROMORPHONE 0.1-0.2 mg/kg q2-4h.
  - MORPHINE 0.2-0.5 mg/kg q4-6h
- For CRI supplementary analgesia, use one of the following drugs:
  - FENTANYL 2-10 mcg/kg/h.
  - MORPHINE 0.1-0.25 mg/kg/h.
  - HYDROMORPHONE 0.02-0.05 mg/kg/h.
- For PO supplementary analgesia, use TRAMADOL 5-10 mg/kg PO q8-12h for up to 5 days.

Caution: Do NOT use acetaminophen or ibuprofen in MWDs, as these drugs can cause liver toxicity. AVOID use of NSAIDs such as naproxen, meloxicam, and aspirin in emergently ill or injured MWDs.

Opioid Reversal

At appropriate doses, dogs appear less susceptible to opioid-induced respiratory depression and excessive sedation. However, opioid side effects can be reversed in the dog using NALOXONE 0.01-0.02 mg/kg slow IV to effect if needed. Note that this will reverse analgesia as well as sedation!

Ancillary Support

- Any MWD that is deeply sedated or under general anesthesia should be given IV crystalloid fluid therapy at 10 mL/kg/h to offset anesthesia-induced hypotension. Additional fluid volumes may be necessary based on the underlying problem (e.g., shock should be given IV fluids to targeted endpoints, as per Chapter 6, Figure 33).
- Active warming should be provided for any MWD that is deeply sedated or under general anesthesia. Use forced-air warmers, warm water circulating blankets, heat-retaining covers, and warming tables to target a body temperature of 100-101° F. Monitor temperature post-procedure until sustained >100^0 F.
- Basic and advanced monitoring of the MWD at a level considered appropriate for a human patient for the respective level of analgesia or anesthesia must be provided. Table 20 lists key monitoring parameters and goals for anesthetized MWDs, and common anesthesia machine settings.

TABLE 20. KEY MONITORING PARAMETERS & ANESTHESIA MACHINE SETTINGS

Parameter	Normal Values	Notes
Heart rate	60-100 bpm	See Chapter 2 for placement of ECG electrodes
Heart rhythm	Normal sinus	
Blood pressure	MAP >60 mmHg	Non-invasive technique
Pulse oximetry	97 ± 2%	See Chapter 2 for placement
Capnography	E_TCO_2: 35 – 45 mmHg	Up to 60 mmHg is permissible in a normoten-sive, spontaneously ventilating patient
Temperature	99 - 102.5 ^{0} F	Continuous recording probes can be inserted into the esophagus or rectum
Fresh gas flow	1 – 2 L/min	
F_IO_2	0.3 – 1.0 %	
Inhalant agent	Isoflurane: 0.5 – 1.5% Sevoflurane: 1.0 – 3.0 %	
Ventilation modes	Spontaneous (preferred) Volume controlled: TV=10-20 mL/kg Pressure controlled: PIP=1-25 cmH_2O BPM = 6-12 PEEP: 0 – 5 cmH_2O	

Analgesia and Anesthesia Reference

US Army Public Health Command, Veterinary Medical Standardization Board, Anesthesia and Pain Management Standards, 10 October 2013.

Traumatic Brain Injury and Acute Spinal Cord Injury

Traumatic brain injury (TBI) and acute spinal cord injury (ASCI) are uncommon in MWDs. These injuries are often catastrophic, with poor long-term outcome. Caring for affected MWDs is daunting and can tax resources. However, some CNS injuries are recoverable, so efforts to evaluate MWDs with TBI and ASCI should be made to determine the severity of injury and potential for successful outcome. Anticipate these injuries in MWDs exposed to building collapses, blast, and ballistics injuries.

Acute Spinal Cord Injury

Assume ASCI is present in every MWD trauma patient until proven it is not present. Maintain a high index of suspicion! 40-50% of MWDs with ASCI have concurrent injury elsewhere that may be more life-threatening.[1] Focus on initial resuscitation and stabilization, but constantly consider potential neurological injuries. Excessive movement can cause a partial injury to become a permanent injury. Limit movement during the initial exam and treatment period to that which is absolutely necessary until a detailed neurological exam is performed.

Clinical Signs Suggesting ASCI

Clinical findings of bruising over any part of the spine; spinal instability, misalignment, crepitus or pain along the spine; presence of head injury or altered mentation or level of consciousness; or major trauma to other body systems are early tips that ASCI may be present.

Specific neurological signs that strongly suggest ASCI include loss of conscious proprioception, loss of superficial and deep pain, and loss of function (paresis or paralysis).

Lesion Localization

It is ideal to localize the segment of the cord affected. Determine if upper motor neuron (UMN) or lower motor neuron (LMN) signs are present.

- **UMN signs** are characterized by increased motor tone causing normal or exaggerated limb reflexes, normal to increased muscle tone, and decreased proprioception and decreased superficial and deep pain sensation in areas caudal to the lesion.
- **LMN signs** are characterized by flaccid or weak motor tone causing depressed limb reflexes and decreased muscle tone in areas caudal to the lesion.

With both UMN and LMN involvement, paresis or paralysis are possible.

- C1-C5 – UMN signs to all 4 limbs, possibly abnormal respiration (shallow or absent).
- C6-T2 – UMN signs to the hind limbs and LMN signs to the forelimbs.
- T3-L3 – UMN signs to the hind limbs with normal forelimbs.
- L4-S2 – LMN signs to the hind limbs with normal forelimbs.

Diagnostic Imaging

Radiographs, CT, or MRI are often necessary for definitive diagnosis in patients with fractures or dislocations to determine the site of injury. If these imaging modalities are available and the MWD can be managed without worsening possible injury, attempt imaging (See Chapter 20). Heavy sedation or anesthesia will be necessary (See Chapter 16).

General Management Considerations for Patients with ASCI

Goals are to reduce neurological deficit and prevent further loss of neurological function (See Figure 46).

- Follow guidance in this CPG for management of shock, hypotension, hypovolemia, hemorrhage control, and respiratory dysfunction. Be prepared to intubate patients that are not breathing or have depressed ventilation. Careful intubation using manual in-line stabilization (MILS) is essential to minimize further injury.
- If signs suggest ASCI are present and the MWD is NOT ambulatory, immobilize the MWD using a backboard (plywood sheet, plastic board, EMS backboard, etc.) to which the animal is taped, and sedate with or without analgesia as often as necessary to prevent unwanted patient movement due to anxiety and pain.
- If signs suggest ASCI is present and the MWD IS ambulatory or adequate immobilization is not possible (due to lack of sedative/analgesia or support devices or patient temperament), confine the MWD to a small area or kennel and prevent excessive movement until evacuated.
- Do NOT use nonsteroidal anti-inflammatory drugs (NSAIDs).
- Do NOT give corticosteroids to MWDs with ASCI, UNLESS the animal has no deep or superficial pain, is paralyzed, or the neurological condition deteriorates. If corticosteroids are given, use ONLY a SINGLE dose of methylprednisolone sodium succinate, IV, 30 mg/kg over 15 minutes.

Conservative Management of ASCI

Indications for conservative (non-surgical) treatment include patients that are ambulatory or paraparetic, and patients that have strong voluntary movement and peripheral pain sensation.

- Maintain enforced confinement, analgesia, and sedation as needed to minimize movement.
- Evacuate URGENTLY if feasible.

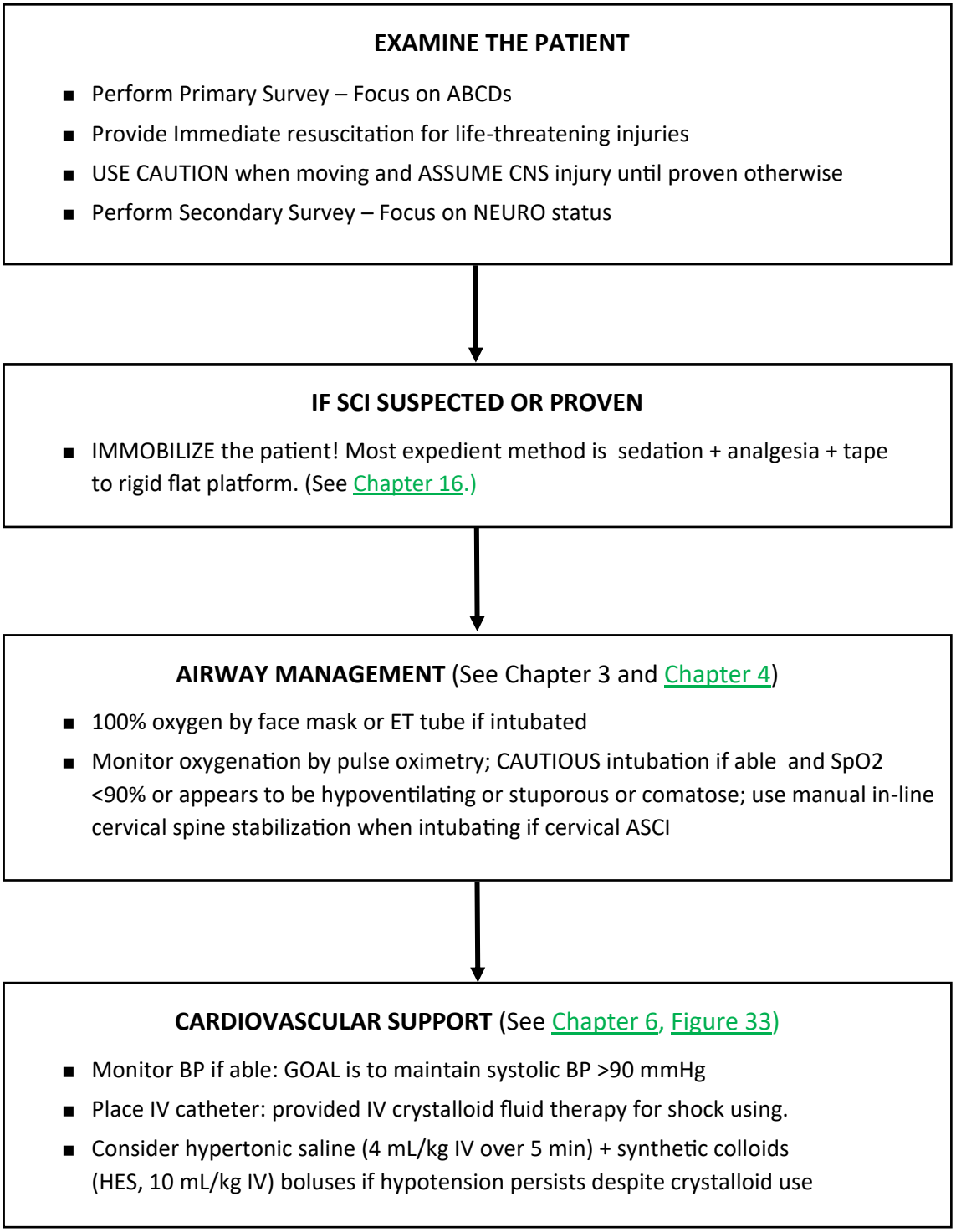
Surgical Management of ASCI

Early definitive surgical correction is indicated in non-ambulatory patients, patients with palpably unstable or displaced injuries, patients that deteriorate with conservative therapy, patients with peripheral pain sensation but no voluntary movements, and patients requiring decompressive surgery to correct displaced or fractured

spinal segments or bone fragments. Surgical management is likely not be feasible in a deployed setting.

- Definitive surgical repair of ASCI in MWDs should only be performed by qualified veterinary personnel.
- Evacuate as soon as feasible, or consider euthanasia (Chapter 21) if severe ASCI is present based on physical exam, diagnostic imaging results, lack of deep or superficial pain, or paralysis is present at any time.

Figure 46. Clinical Management Algorithm for Acute Spinal Cord Injury in MWDs.



Traumatic Brain Injury

There is limited data on TBI in animals. Anticipate TBI in MWDs after trauma in 25-40% of cases.[2-6] TBI carries an extremely high mortality; assume a prehospital mortality of >40% in severe TBI cases. Management of MWDs is largely based on recommendations for treating people. Care by HCPs should be directed at efforts to mitigate secondary injury from hypotension, hyperthermia, hyper- and hypoglycemia, hypoxia, hyper-and hypocapnia, acid-base imbalances, electrolyte imbalances, SIRS, MODS, and ARDS. Thus, HCP care should be directed at maintenance of blood pressure, normoxemia, normal ventilation, and normal body temperature.

Clinical Signs Suggesting TBI

Brain injury should be suspected in any trauma patient with altered mentation (coma, stupor, depression, lethargy, inappropriate behavior or responses) or with physical evidence of head trauma (e.g., lacerations, abrasions, bruising, swelling, pain, bleeding from the nose or ears).

- Pay special attention to the patient's level of consciousness (LOC), overall pain response, pupillary light responses, cardiac and respiratory changes, motor activity and reflexes, and body temperature.
- The external ear canals and nasal openings should be examined for evidence of blood or CSF.
- The presence of lateralizing neurologic signs in a patient with brain injury suggests underlying intracranial hemorrhage; whereas patients with diffuse CNS deficits more probably have significant intracranial edema as a cause or contributor to their neurologic dysfunction.[2-5] These findings will affect treatment options.
- MWD posture on presentation may allow injury localization and estimation of prognosis. While these classic postures are not always noted, their presence can be used by first responders to identify severe TBI with poor-to-grave prognoses.
  - Patients with injury to the T2-L2 thoracic spine often display the Schiff-Sherrington syndrome (Figure 47, inset A), typically with normal mentation, forelimbs in extensor rigidity, and hind limbs that are flaccid. The prognosis for these patients is usually grave due to severe spinal cord trauma.
  - Patients with decerebellate rigidity (Figure 47, inset B) typically are obtunded or depressed, have

Figure 47. Characteristic Neurologic Postures on Presentation.

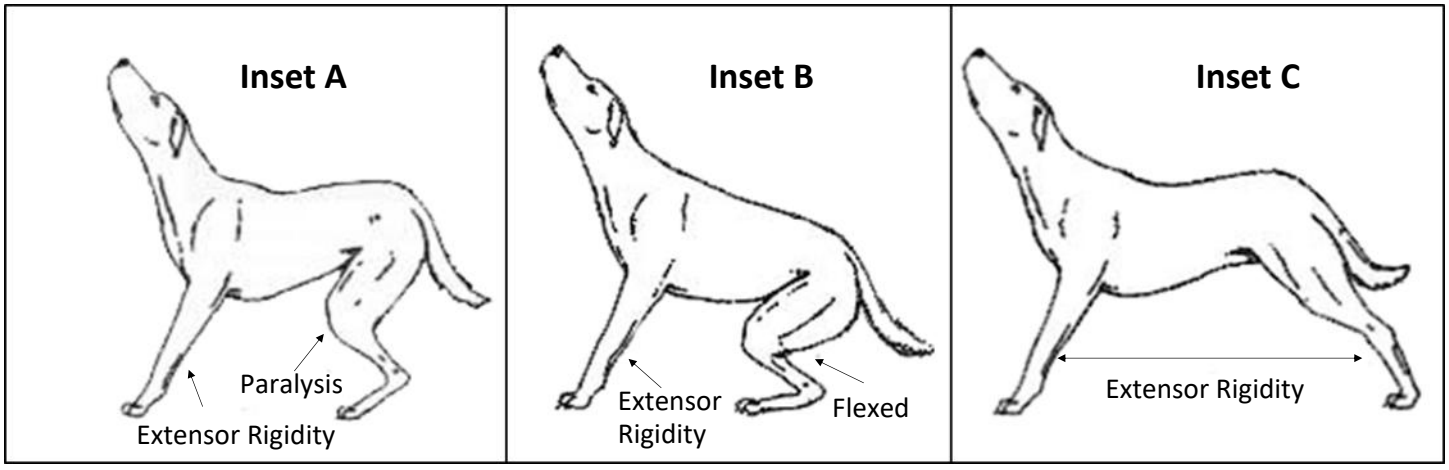


TABLE 21. MODIFIED VETERINARY GLASGOW COMA SCALE[7]	
Level of Consciousness	**Score**
Occasional periods of alertness and responsive to environment	6
Depression or delirium, capable of responding but response may be inappropriate	5
Stupor – semi comatose, responsive to visual stimuli	4
Stupor – semi comatose, responsive to auditory stimuli	3
Stupor – semi comatose, responsive only to repeated noxious stimuli	2
Comatose – unresponsive to repeated noxious stimuli	1
Motor Activity	
Normal gait, normal spinal reflexes	6
Hemiparesis, tetraparesis, or decerebrate activity	5
Recumbent, intermittent extensor rigidity	4
Recumbent, constant extensor rigidity	3
Recumbent, constant extensor rigidity with opisthotonus	2
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1
Brainstem Reflexes	
Normal PLRs and oculocephalic reflexes	6
Slow PLRs, normal to reduced oculocephalic reflexes	5
Bilateral unresponsive miosis, normal to reduced oculocephalic reflexes	4
Pinpoint pupils, reduced to absent oculocephalic reflexes	3
Unilateral unresponsive mydriasis, reduced to absent oculocephalic reflexes	2
Bilateral unresponsive mydriasis, reduced to absent oculocephalic reflexes	1

opisthotonus, have fore limbs in extensor rigidity, and hind limbs in active flexion. These patients have a guarded prognosis due to severe injury to the cerebellum.

- Patients with decerebrate rigidity (Figure 47, inset C) typically are obtunded, have opisthotonus, and the fore limbs and hind limbs are in extensor rigidity. The prognosis for these patients is grave due to severe injury to the cerebrum.

Assessing Severity of TBI in MWDs

A modified veterinary Glasgow Coma Scale (Table 21 above) is validated for use in dogs.[7] Data is limited, however, correlating long-term outcome (i.e. prognostication) with initial or serial assessment of GCS in dogs.

- As with people, the lower the total GCS, the worse the TBI and the lower the expected survival with neurological function intact.
- Limited use in veterinary trauma patients has allowed development of suggested prognoses based on the MVGCS (See Table 23). HCPs should use this guidance when assessing severity of TBI and resource allocation.

TABLE 22. SUGGESTED PROGNOSES BASED ON MODIFIED VETERINARY GLASGOW COMA SCALE[7]	
MVGCS Score	**Suggested Prognosis**
3-8	Grave
9-14	Guarded
15-18	Good

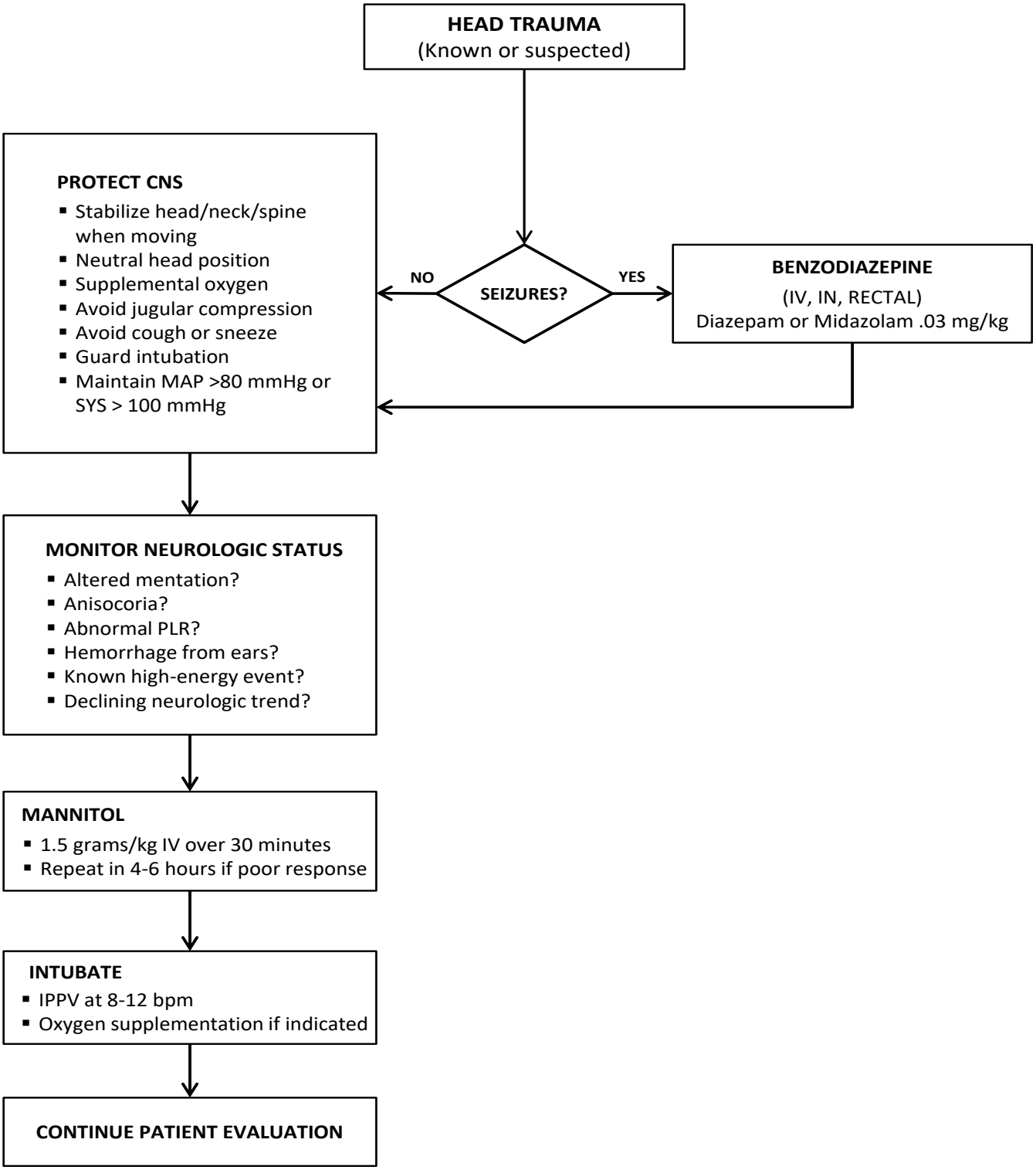
General Management Considerations for MWDs with TBI

It is critical to ensure adequate resuscitation and management of cardiovascular and respiratory problems, as hypotension, poor tissue perfusion, and hypoxia lead to progressive brain injury due to the adverse effects of secondary neurological injury due to ischemia, cerebral edema, reperfusion injury, and so forth. (See Figure 48 on the next page.)

- Follow guidance in this CPG for management of shock, hypotension, hypovolemia, hemorrhage control, and respiratory dysfunction.
- Be prepared to intubate patients that are not breathing or have depressed ventilation; careful intubation using manual in-line stabilization (MILS) is essential to minimize further injury.
- Focus care on preventing hypoxemia, maintaining cerebral perfusion pressure and systemic arterial pressure in the normal ranges, and preventing secondary ischemic cerebral injury.
  - Provide 100% oxygen by facemask. Monitor respiratory rate and effort. Be prepared to intubate and provide supplemental oxygen by ET tube. Maintain arterial carbon dioxide content in the normal range using assisted manual ventilation. Avoid hyperventilation!
  - Maintain normotension (MAP 70-80 mmHg or systolic BP >90 mmHg). Start IV crystalloid fluid therapy to correct shock and provide ongoing volume support (See Chapter 6, Figure 33). Measure blood pressure if possible; otherwise, guide fluid therapy based on presence or absence of distal pulses. Consider hypertonic saline (4 mL/kg IV over 5 min) or hyperoncotic fluid (HES, 10 mL/kg IV) boluses if hypotension persists despite crystalloid use.
  - Nurse with head elevated 30^0 with neutral neck position, avoid external jugular vein compression and catheters, avoid procedures that stimulate coughing or sneezing.
  - If evacuation will be prolonged and the patient is recumbent, rotate lateral recumbency and lubricate the eyes with ophthalmic ointment every 4 hours and maintain in a well-padded area.
  - If the MWD is conscious, restrict activity and movement (e.g., portable kennel), which may require sedation and analgesia (See Chapter 16).

(Continued on page 70)

Figure 48. Management Algorithm for TBI for MWDs.



- Give mannitol, 1.5 grams/kg, IV, over 30 min for MWDs with a MVGCS score of ≤ 8. Repeat this dose once more 4-6 hours after the first dose.
  Note that dogs are less likely to suffer subdural or intracranial hemorrhage; thus, mannitol should be used early in any MWD with moderate-to-severe TBI (MVGCS ≤ 8).
- ***Do NOT use corticosteroids to treat MWDs with TBI.***

Prognosis

HCPs must be realistic when treating MWDs with ASCI and TBI. While efforts and resources should be extended for MWDs with mild-to-moderate ASCI and TBI, HCPs should consider the likelihood of return to function. Consider euthanasia (See Chapter 21) for MWDs with catastrophic neurological injuries, or dogs with paralysis and that fail to respond to therapy or deteriorate despite care.

TBI and ASCI References

1. Park EH, White GA, Tieber LM. Mechanisms of injury and emergency care of acute spinal cord injury in dogs and cats. J Vet Emerg Crit Care 2012;22:160-178.
2. Dewey CW. Brain trauma. In: The Veterinary ICU Book. Teton NewMedia, Jackson, WY, 2003;910-920.
3. Finnie JW. Forensic pathology of traumatic brain injury. Vet Pathol 2016;53:962-978.
4. Fletcher DJ and, Syring RS. Traumatic brain injury. In: Small Animal Critical Care Medicine, Silverstein DC and Hopper K, eds. Saunders/Elsevier, St Louis, MO, 2015;723-727.
5. Sande A, West C. Traumatic brain injury: a review of pathophysiology and management. J Vet Emerg Crit Care 2010;20:177-190.
6. Sharma D, Holowaychuk MK. Retrospective evaluation of prognostic indicators in dogs with head trauma: 72 cases (January-March 2011). J Vet Emerg Crit Care 2015;25:631-639.
7. Platt SR. Coma scales. In: Small Animal Critical Care Medicine, Silverstein DC and Hopper K, eds. Saunders/Elsevier, St Louis, MO, 2015;422-425.

CHAPTER 18

Canine Post Traumatic Stress Disorder (C-PTSD)

The Canine Post Traumatic Stress Disorder (C-PTSD) chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 19

Training and Toxicoses in MWDs

MWDs are exposed to small quantities of select drugs and explosives, contained in specially-constructed containers called training aids. Training aid ingestion and toxicity are events unique to MWDs and working dogs employed by law enforcement agencies.

- Training aids that are of concern when ingested include nitrate-based explosives (TNT, water gel, dynamite, RDX , detonation cords, and C-4), smokeless powder, sodium and potassium chlorates, and drugs (marijuana, heroin, cocaine, and amphetamines).[1]
- Potential toxicity is a concern and it is plausible that HCPs will be presented with an MWD that has ingested a training aid and is or may become toxic.

Clinical Signs of Intoxication (by Agent)

MWD handlers will have critical knowledge of the agent to which an MWD was exposed, for training aid ingestion. Common agents used and associated clinical signs follow.

- **Nitrate/nitroglycerin-based explosives.** Ingestion may result in hypersalivation, severe CNS abnormalities (ataxia, incoordination, seizures, tremors), gastrointestinal irritation (nausea, vomiting), and methemoglobinemia (cyanosis, weakness, syncope, respiratory distress).
- **Smokeless powder explosive.** Ingestion may result in hypotension, CNS depression (ataxia, depressed mentation, incoordination), and methemoglobinemia (cyanosis, weakness, syncope, respiratory distress).
- **Potassium and sodium chlorate explosives.** Ingestion may result in methemoglobinemia (cyanosis, weakness, syncope, and respiratory distress), CNS abnormalities (ataxia, incoordination, and depressed mentation), gastrointestinal irritation (nausea, vomiting, abdominal cramping and pain, hemorrhagic diarrhea with melena or hematochezia), hematuria, hemoglobinuria, and renal and liver failure.
- **Marijuana/hashish.** Ingestion may result in altered mentation (disorientation), hallucinations (in the dog, typically manifested as vocalizing, useless scratching, hyperexcitability), nausea and vomiting, and respiratory distress.
- **Heroin.** Ingestion may result in bradycardia, respiratory distress, miosis, coma, and sudden death.
- **Cocaine and amphetamines.** Ingestion may result in restlessness, tachycardia, hyperexcitability, vocalization, excessive or unprovoked aggression, seizures, and mydriasis.

Treatment of Training Aid Toxicity[1]

If ingestion occurred ≤ 4 hours before presentation and the MWD is conscious and has normal CNS responses, induce vomiting.

- Apomorphine is the drug of choice to induce vomiting in the dog. MWD handlers are issued apomorphine in tablet form, which is generally available in 6 mg tablets. If available, place ¼ to ½ tablet into either conjunctival sac. Vomiting typically occurs in 5-10 minutes. Once vomiting has occurred, rinse residual apomorphine from the conjunctival sac.
- Apomorphine may be available in the HCP drug inventory as an injectable agent (10 mg/mL). If the injectable form is available, give 0.03-0.04 mg/kg IV. Emesis is typically evident within 5 minutes in most MWDs.
- An alternative is to give hydrogen peroxide orally if apomorphine is not successful or available. Give 1 mL per kilogram body weight of hydrogen peroxide 3% orally. Note that hydrogen peroxide is less successful than apomorphine.
- Do NOT use Syrup of Ipecac or salt, or try to induce vomiting manually. These methods are ineffective in the dog and risk intense gastrointestinal irritation in the dog, and bite wounds to the HCP.

If ingestion occurred >4 hours before presentation, or if the dog has abnormal mentation or is unconscious or seizuring, do not induce vomiting. In these cases, balance the benefit of gastric decontamination by orogastric lavage against the very real risk of aspiration pneumonia. If gastric lavage is elected, induce general anesthesia (See Chapter 16) and ensure a cuffed endotracheal tube is used. Lavage the stomach using repeated instillations of water at a dose of 10-20 mL/kg. Maintain the cuffed endotracheal tube until the MWD has regained a swallowing reflex.

The next critical step in management of any training aid toxicity is to administer activated charcoal.

- The dose for activated charcoal is 1.5 grams/kg PO. Most MWDs will ingest activated charcoal if the charcoal is mixed with canned food. If the MWD will not ingest the charcoal voluntarily, either have the handler syringe the slurry slowly orally or (if the MWD is anesthetized) give the slurry by orogastric tube. MWD handlers are issued Toxiban® with sorbitol and may have initiated therapy prior to presentation.
- Activated charcoal WITH sorbitol as a cathartic is preferred as the initial dose.
- Repeat activated charcoal once in 4-6 hours. This dose should not include sorbitol.

If seizures are present or develop, treat the MWD with a benzodiazepine.

- Give midazolam (0.3 mg/kg IV or IN) or give diazepam (0.3 mg/kg IV, IN, or per rectum).
- Repeat in 10-15 minutes if seizures persist or recur.

If methemoglobinemia is suspected or confirmed and deemed causing significant respiratory distress, treat with methylene blue (if available).

- The dose for methylene blue 1% in the dog is 1-2 mg/kg IV slow bolus.
- This dose can be repeated once or twice if respiratory distress persists.
- Methylene blue can cause severe Heinz body anemia in the dog, so monitor an HCT q6-8h if this drug is used.

Toxicoses in MWDs Reference

Bright PA. Military working dog training aids: toxicity and treatment. Air Force Occupational and Environmental Health Laboratory (AFSC), Human Systems Division, Brooks Air Force Base, TX, 1989;1-32.

CHAPTER 20

Diagnostic Imaging

Diagnostic imaging of injured or ills dogs is frequently required for comprehensive patient evaluation. Veterinary facilities may not be equipped for imaging, or may be limited to plain radiography. Advanced imaging (e.g., MRI, CT) is often ideal, and veterinary facilities do not have these capabilities. This chapter provides guidance for HCPs with extensive training in the use of CT and MRI, when considering advanced imaging requirements, highlighting unique aspects when imaging dogs.

Computed Tomography vs Magnetic Resonance Imaging

CT is often superior to MRI and used for assessment of margins of osseous or mineralized structures compared to MRI. CT can assess soft tissue changes and differences fairly well by narrowing windows and levels under standard algorithms to see differences of attenuation of the x-rays, but cannot manipulate the soft tissues due to their molecular structure as MRI can in order to enhance or null their differences. Therefore, MRI is often far superior to CT at assessing for subtle changes within soft tissues due to the dramatic contrast enhancement. MRI is most often utilized in veterinary medicine and is the modality of choice when you are trying to assess soft tissue structures not easily accessed by an ultrasound probe or are looking for diseases that may not be appreciated via any other modality. MRI is used primarily for neurologic (brain and spine) imaging and joint imaging concerning cartilage, ligaments, and/or menisci. Keeping those general statements in mind, depending on the type of disease you are assessing for you may be able to appreciate the abnormalities on both modalities, so either study may be adequate for diagnosis. References are provided with specific imaging protocols for MWDs.[1-5]

Computed Tomography[3,4]

Sedation/Anesthesia

The patient must be either heavily sedated or anesthetized while the study is taking place. CT studies of the thorax and abdomen require general anesthesia and intubation of the patient, with closure of the pop-off valve on the anesthetic machine during image acquisition. Depending on how advanced the CT machine is and slice thicknesses needed, this may or may not be a problem for the patient, as the breath hold may have to last for several seconds. ***Always ensure anesthesia pop-off valves are not left closed, to avoid pneumothorax.***

Contrast Administration

Intravenous iodinated contrast may be used during a CT study in order to further enhance margins of soft tissue structures. If a CT is being conducted to assess an abnormal soft tissue mass or structure, intravenous iodinated contrast should be administered after acquisition of routine images prior to contrast administration for comparison purposes. This contrast administration allows for further characterization of the abnormal soft

tissue as only the vascular portions of the structure will enhance.

- The current standard for use of contrast during CT is non-ionic iodinated contrast media, with the two most common types being iohexol and iopamidol. Iohexol is most commonly used in MWDs. For a vial of iohexol at a concentration of 240mg/mL, the intravenous contrast dose is 400 mg/kg (rule of thumb is 1 mL of contrast agent per pound of body weight, not to exceed 60 mL).
- IV catheterization of the patient is required for contrast administration, and the contrast is a thick, sticky solution which needs to be bolused to the patient, so use 18 gauge catheters and syringe needles.
- After bolusing the contrast to the patient, only the study in the standard algorithm needs to be repeated.
- If the patient is dehydrated, the patient should be rehydrated prior to the CT study if possible or at least on IV fluids to correct the problem if unavoidable.
- Adverse side effects are rare with non-ionic contrast media in correctly hydrated patients.

CT Protocols

CT protocols will vary per region you are attempting to image, patient positioning, slice thickness, algorithms, and whether or not contrast will be used. Each of these factors is critical, but the most commonly overlooked factor is patient positioning. Ensure the region of the patient you are imaging is straight and symmetrically positioned on midline of the CT table, as subtle changes in obliquity may make structures appear abnormal when they are not. Use positional aids, sponges, or troughs if needed, and ensure that all metallic or other unnecessary objects are removed. Place the patient either head-first or hindlimb-first into the gantry, depending on which will be closest to the region for imaging. The following are recommended protocols for different body regions based on common problems seen in MWDs.

CT Skull

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies should extend from the tip of the nose to the 2nd to 3rd cervical vertebra. Bone, standard, and bone algorithms with slice thicknesses of 2.5 mm, 1.25 mm, and 0.625 (if available) should be performed, respectively. Sagittal and dorsal reconstructions should be made as needed.

CT Nasal

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies should extend from the tip of the nose to the larynx. A bone algorithm with slice thicknesses of 2.5 mm and 0.625 mm (or equivalent) and a standard algorithm with slice thickness of 1.25 mm should be performed. Intravenous contrast should be administered, and the standard algorithm with 1.25 mm thick slices repeated. Dorsal reconstructions are required. Sagittal reconstructions should be made as needed.

CT Brain

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies

should extend from mid-muzzle to the 2nd to 3rd cervical vertebra. Bone, standard, and brain algorithms with slice thicknesses of 2.5 mm, 1.25 mm, and 1.25 mm should be performed, respectively. IV contrast should be administered and brain and standard algorithms repeated. Sagittal and dorsal reconstructions of the standard algorithms are required.

CT Tympanic Bullae

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies should extend from the orbits to the 2nd or 3rd cervical vertebra. Bone and standard algorithms with slice thicknesses of 0.625 - 1.25 mm and 1.25 mm should be performed, respectively. Sagittal and dorsal reconstructions should be made as needed.

CT Spine

Patient should be positioned in dorsal recumbency, with the hind limbs maximally extended caudally (like for a hip-extended VD pelvic view in radiography). Study should extend through necessary vertebral regions based on pain and/or neurolocalization. More specifically for the hind limbs, if UMN signs are present, extend from T8-T9 through sacrum, and if LMN signs present, from T12-T13 through sacrum. CT slices should be acquired perpendicular to vertebral canal (may require gantry rotation). A bone algorithm with 2.5 mm and 1.25 mm slice thicknesses and a standard algorithm with 1.25 mm slice thickness should be performed. For suspect lumbosacral disease, the bone algorithm of 1.25 mm slice thickness should be replaced with 0.625 mm (or equivalent) slice thickness to better visualize the neuroforamina at the lumbosacral junction. Sagittal and dorsal reconstructions of bone and standard algorithms are required.

CT Thorax

Anesthesia and breath holds are required. Patient should be positioned in ventral recumbency. Study should extend from thoracic inlet through caudal aspect of liver (ensure extent of all lungs imaged). Bone, standard, and lung algorithms should be performed with slice thicknesses at 5.0 mm, 2.5 mm, and 1.25-2.5 mm, respectively. Sagittal and dorsal reconstructions of lung and standard algorithms are required.

CT Abdomen

Anesthesia and breath holds are required. Patient should be positioned in dorsal recumbency. Study should extend from caudal margin of cardiac silhouette through pelvic canal (or prostate if male). Bone and standard algorithms should be performed with slice thicknesses at 5.0 mm and 2.5 mm, respectively. Sagittal and dorsal reconstructions of bone and standard algorithms are required.

CT of Extremity or Joint

Patient positioning depends on whether imaging forelimbs or hindlimbs. For forelimbs, the patient is in ventral recumbency. The forelimbs should be extended cranially, resting the forearms and paws on the table with the elbows and shoulders bent at a normal resting position. If the hindlimbs are the focus of the study, the patient is usually placed in dorsal recumbency. The hindlimbs should be placed in maximal caudal extension, keeping both limbs symmetric and including both in the study for comparison purposes (use tape, sponges, or other

positional aids). CT slices should be acquired perpendicular to joint spaces, which may require gantry rotation if the joint is the focus of the study. Bone and standard algorithms should be performed along the affected region with slice thicknesses of 1.25 mm. If a joint the focus of the study, conducting an additional bone algorithm sequence with a slice thickness of 0.625 mm is required (if available). Sagittal and dorsal reconstructions of the affected limb only are required.

Magnetic Resonance Imaging[5]

Magnetic resonance imaging protocols used in veterinary medicine are more simplified compared to human medicine. However, current protocols are adequate in assessing for the majority of diseases of concern.

Anesthesia

Use either an MRI-safe anesthetic machine or constant rate IV anesthesia protocols (See Chapter 16). Patient monitoring presents challenges in the MR gantry due to increased noise, greater chance of hypothermia, and overall decreased patient accessibility.

MRI Technician Assistance

It is very important for the Veterinary Corps Officer to be present during image acquisition (if available) to help determine the beginning and end points (range) of the study in each plane, due to anatomic differences between humans and dogs (humans have five lumbar vertebrae compared to seven in dogs, for instance). Beginning and end points for the study should be based on neurolocalization.

MRI Contrast Administration

Paramagnetic contrast agents are commonly used during MRI. Contrast agent administration is always required when imaging the brain, and may be necessary for other exams dependent on the case. For example, if neoplasia or diskospondylitis of the spine is suspected, then administration of contrast during a spinal exam is warranted. All pre-contrast sequences must be performed prior to contrast bolus administration. The contrast agent most often used in MWDs for MRI is gadolinium-based, and the dose for IV bolus use in the dog is 0.1 mmol/kg (0.2mL/kg). As a quick rule of thumb, 1 mL per 10 pounds body weight is the appropriate dose.

MRI Protocols

MRI Brain

The patient should be positioned in ventral recumbency with the head encased within an effective coil (often head or cardiac types). Studies should extend from the most cranial limit of the orbits/eyes to the level of the 2nd or 3rd cervical vertebra. Slice thicknesses of 3-5 mm should be used; dependent on how many sequences you have time to perform. The following sequences in each respective plane should be performed:

- Axial/Transverse Plane. T1-weighted, T2-weighted, FLAIR, T1-weighted with contrast.
- Sagittal Plane. T1-weighted, T2-weighted, T1-weighted with contrast.
- Coronal/Dorsoventral Plane. T2-weighted, T1-weighted with contrast (T1-weighted pre-contrast also if time allows).

MRI Spine

The patient should be positioned in dorsal recumbency, and the coil within the table will likely be used. Study should extend through necessary vertebral regions based on pain and/or neurolocalization. More specifically for the hindlimbs, if UMN signs are present extend from the 8th or 9th thoracic vertebra through the sacrum, and if LMN signs are present, from the 12th or 13th thoracic vertebra through sacrum. Slice thicknesses of 2-4 mm should be used; dependent on how many sequences you have time to perform. The following sequences within each respective plane should be performed:

- Axial/Transverse Plane. T1-weighted, T2-weighted (T1-weighted with contrast if indicated).
- Sagittal Plane. T1-weighted, T2-weighted, STIR (T1-weighted with contrast if indicated).
- Coronal/Dorsoventral Plane. T2-weighted (T1-weighted pre and post- contrast administration if indicated).

MRI Stifle/Joint Imaging

The patient should be placed in lateral recumbency, with the affected limb up, with the stifle placed in neutral to moderate extension. Study should at least extend from distal femoral diaphysis to the proximal tibial diaphysis, distal to the tibial crest. A wrist coil is preferable, however if the joint/region to be imaged is too large, then cardiac or other similar coils may be used. Slice thicknesses of 2-3 mm should be used; dependent on how much time you have to complete the study. The following sequences within each respective plane should be performed:

- Axial/Transverse Plane. Proton Density (PD)-weighted (+/- fat sat).
- Sagittal Plane. PD-weighted (+/- fat sat), T1-weighted, T2-weighted (+/- fat sat).
- Coronal/Dorsoventral Plane. PD-weighted (+/- fat sat), T2-weighted (+/- fat sat).

Diagnostic Imaging References

1. American Association of Veterinary Radiologists. MRI protocols for dogs. www.aavr.org
2. Department of Defense Veterinary Service Activity. Handbook of Veterinary Care and Management of the Military Working Dog, 2017. In press.
3. Drees R, Dennison SE, Keuler NS, Schwarz T. Computed tomographic imaging protocol for the canine cervical and lumbar spine. Veterinary Radiology & Ultrasound, 2009;50:74-79.
4. Schwarz T and Saunders J (eds). Veterinary Computed Tomography. Danvers, MA: Wiley-Blackwell, 2011.
5. Gavin PR and Bagley R (eds). Practical Small Animal MRI. Danvers, MA: Wiley-Blackwell, 2009.

Euthanasia

The Euthanasia Chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)

CHAPTER 22

Documentation—Medical Records

The Documentation—Medical Records chapter is updated and is published as a separate guide on the JTS CPG website (https://jts.health.mil/index.cfm/CPGs/cpgs) or the Deployed Medicine website (deployedmedicine.com)